US007845272B2

(12) **United States Patent**
Powers et al.

(10) **Patent No.: US 7,845,272 B2**
(45) **Date of Patent: *Dec. 7, 2010**

(54) **METHOD AND APPARATUS FOR PRODUCTION OF ELONGATED MEAT PRODUCTS WITHOUT CASINGS**

(75) Inventors: **Richard Powers**, Overland Park, KS (US); **Adam E. Anderson**, Leawood, KS (US); **Paul Hardenburger**, Hutchinson, KS (US)

(73) Assignee: **Marlen International, Inc.**, Overland Park, KS (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **12/766,745**

(22) Filed: **Apr. 23, 2010**

(65) **Prior Publication Data**

US 2010/0209579 A1 Aug. 19, 2010

Related U.S. Application Data

(63) Continuation of application No. 12/703,396, filed on Feb. 10, 2010.

(60) Provisional application No. 61/222,765, filed on Jul. 2, 2009, provisional application No. 61/152,576, filed on Feb. 13, 2009.

(51) **Int. Cl.**
A22C 7/00 (2006.01)
A23P 1/00 (2006.01)
A47J 43/18 (2006.01)

(52) **U.S. Cl.** **99/427**; 99/352; 426/513; 425/557; 425/576

(58) **Field of Classification Search** ..... 99/427, 99/384, 483, 441, 352, 443 R, 443 C; 426/92, 426/105, 646, 523; 425/574, 576, 557
See application file for complete search history.

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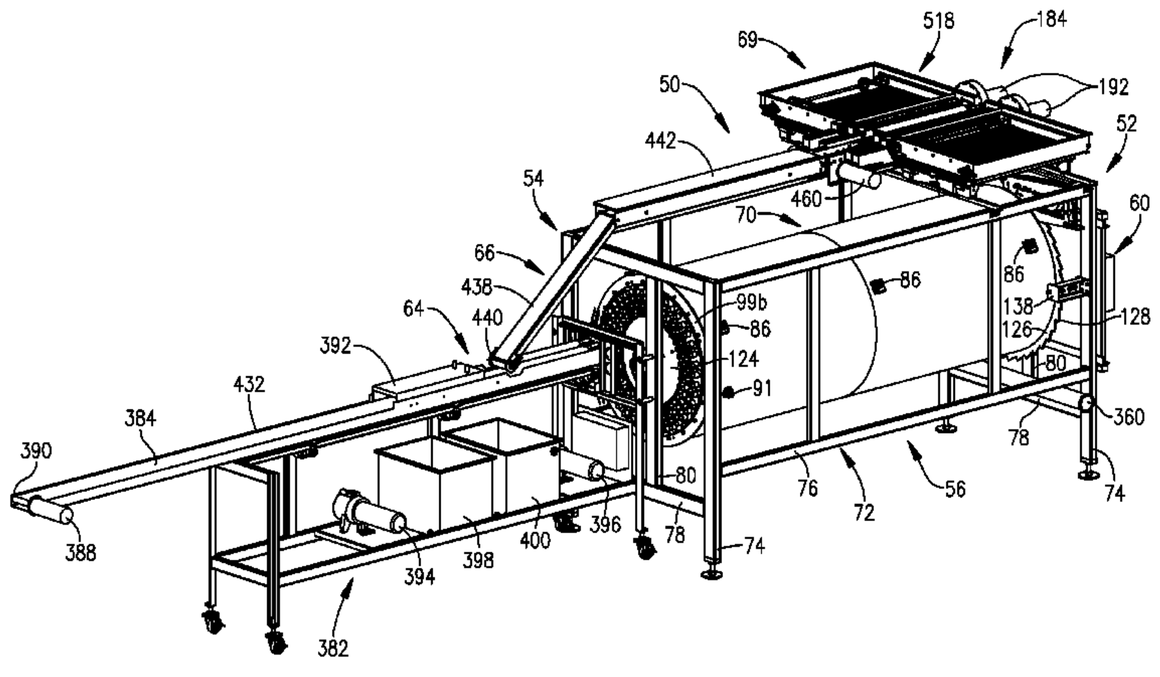
Primary Examiner—Tu B Hoang
Assistant Examiner—Hemant Mathew
(74) *Attorney, Agent, or Firm*—Hovey Williams LLP

(57) **ABSTRACT**

A system (**50**) is provided for the production of elongated comestible products such as hot dogs, without the use of traditional casings. The system (**50**) includes a circular pattern of arrays (**92**) of elongated, open-ended, extruded synthetic resin cooking tubes (**94**, **96**) within a rotatable cylindrical heating drum or housing (**70**). The tube housing (**70**) and arrays (**92**) are incrementally rotated and at each stop position certain of the tubes (**94**, **96**) are filled with portions of meat emulsion (**590**) and alternating plugs (**208**), while previously filled tubes (**94**, **96**) containing cooked product are unloaded, and other unfilled tubes are internally coated with a lubricant (e.g., a mixture of lecithin and vegetable oil). Energy exchange media such as hot water and/or steam are used within the housing to continuously cook the emulsion portions within the tubes (**94**, **96**) to the desired extent.

4 Claims, 29 Drawing Sheets



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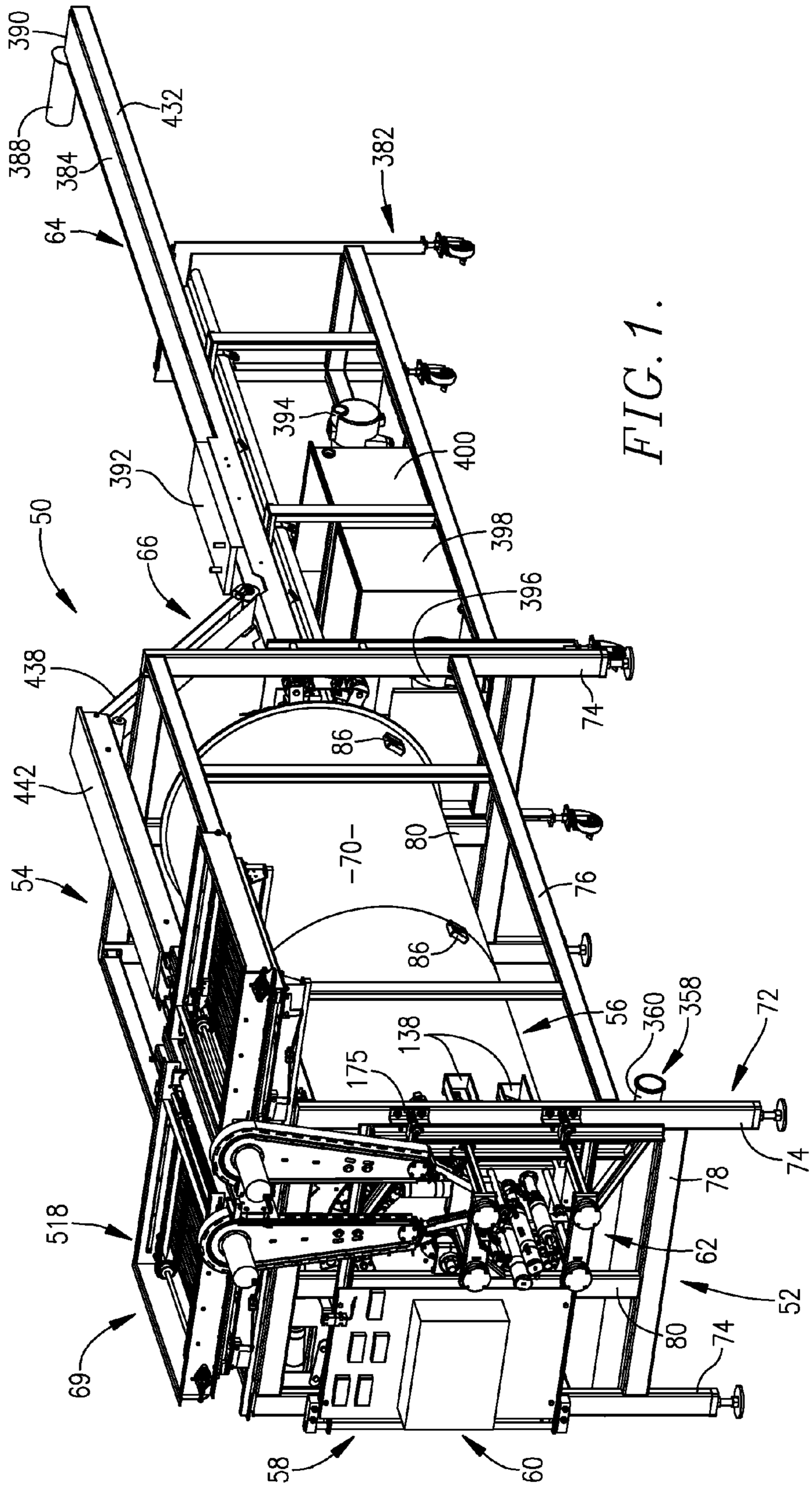
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FIG. 1.

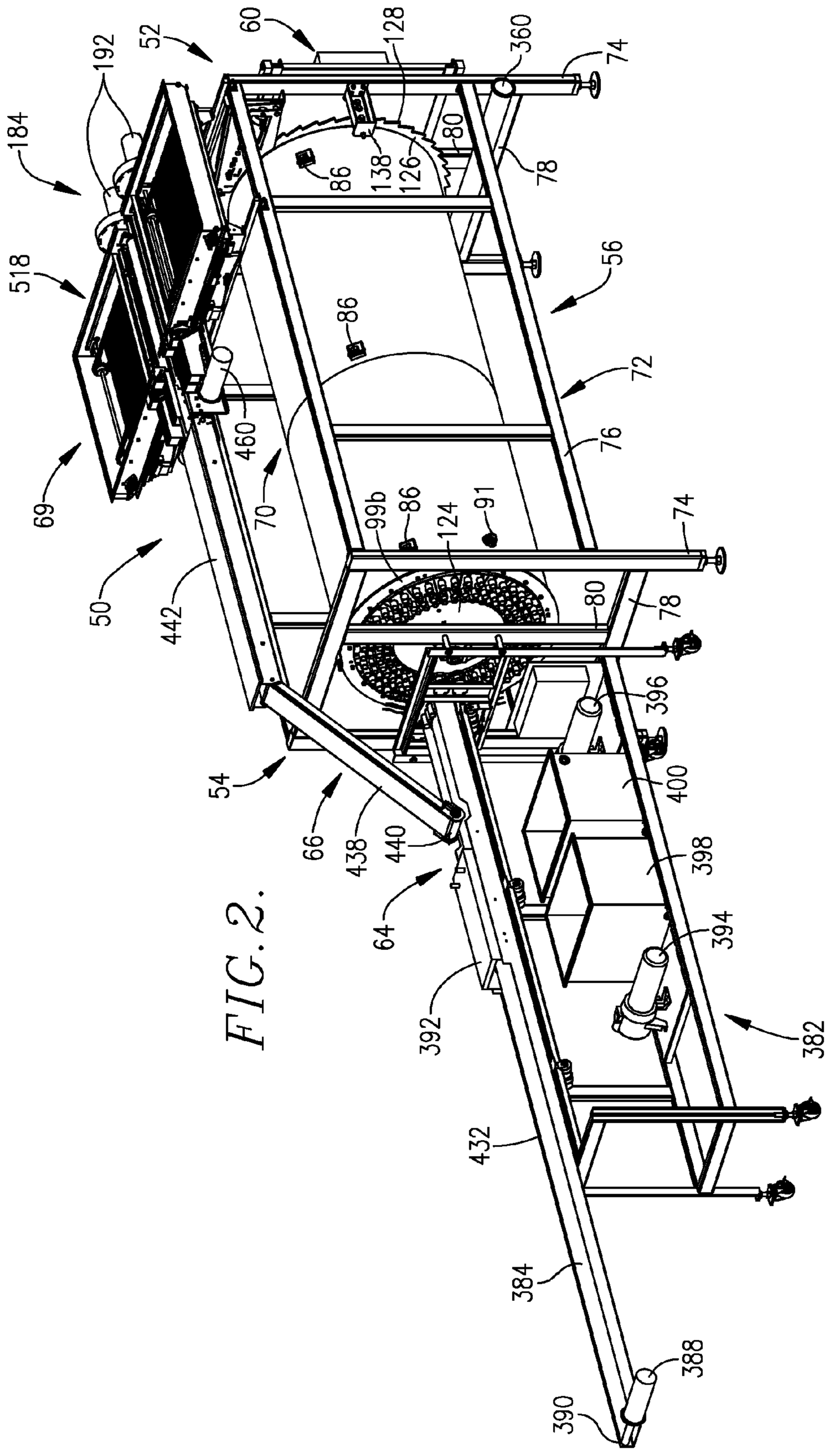
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FIG. 2.

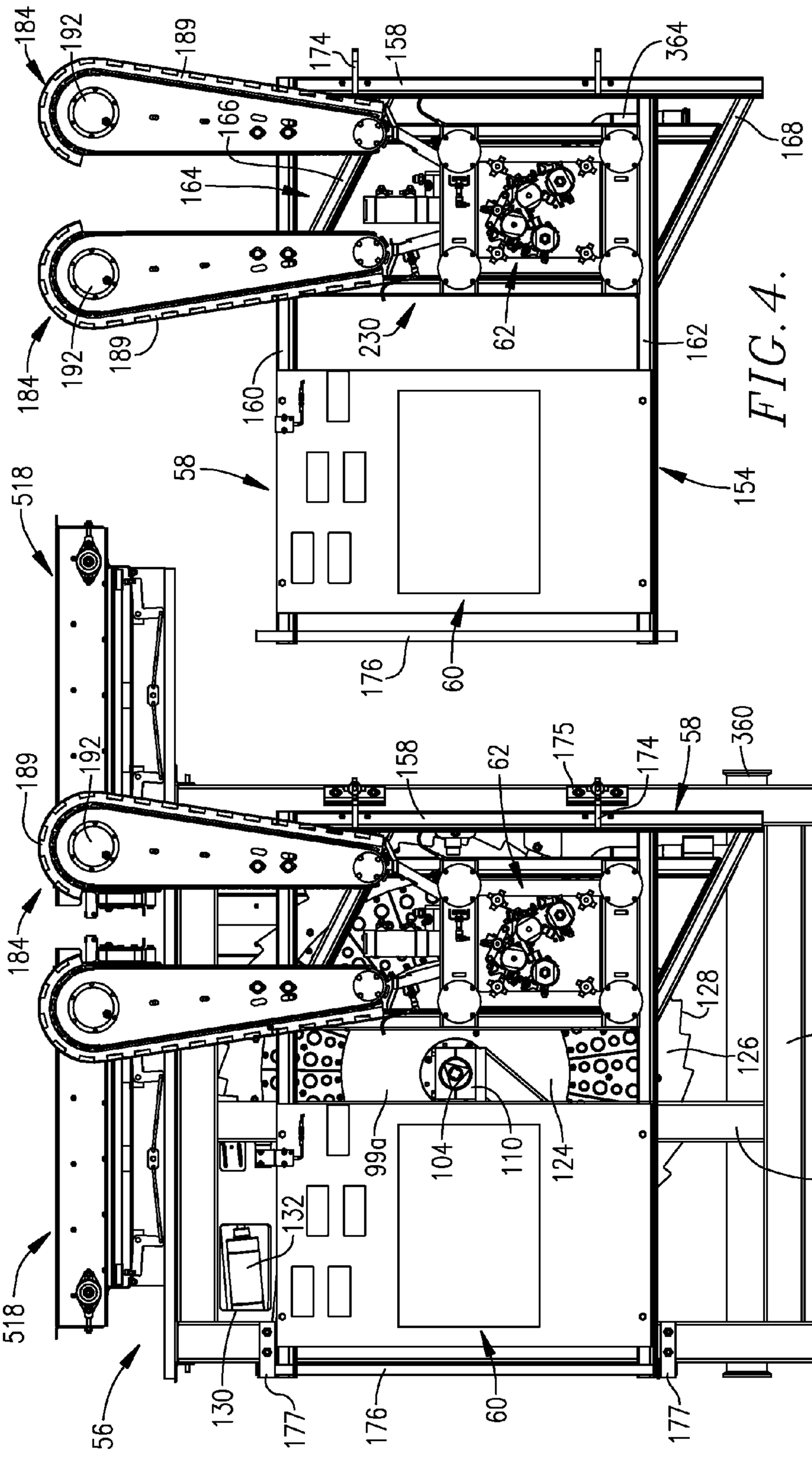
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FIG. 4.

FIG. 3.

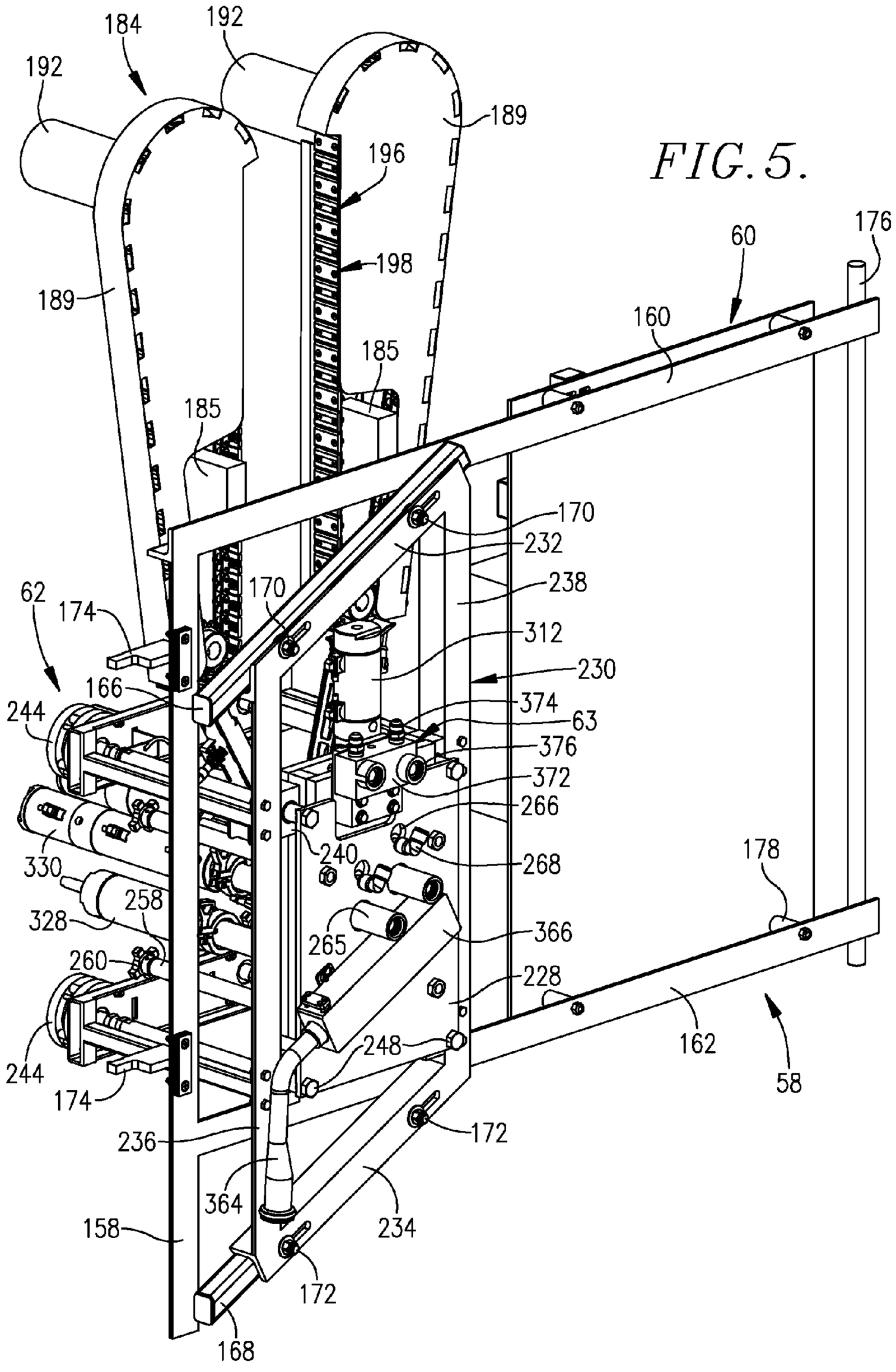
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FIG. 5.

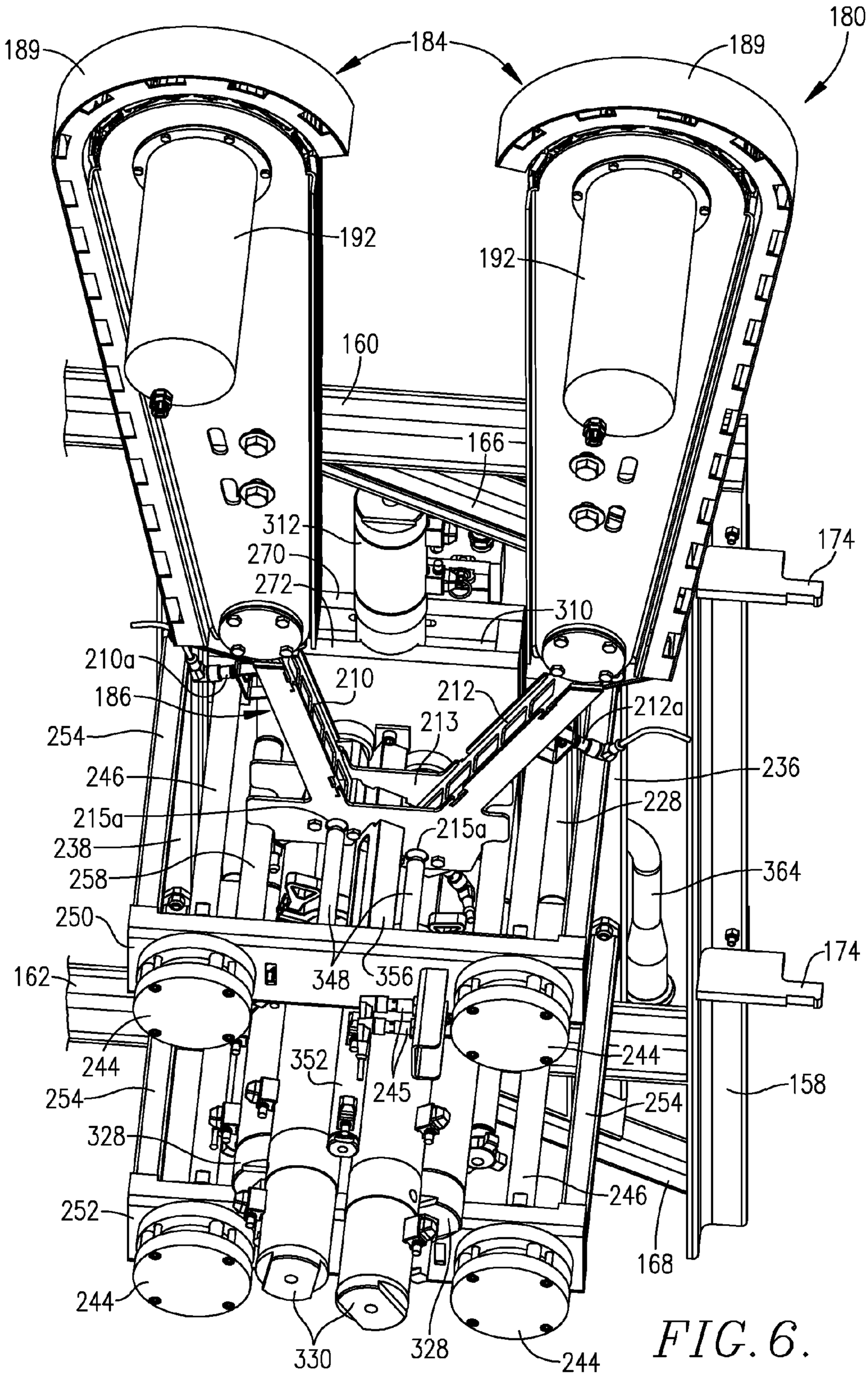
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FIG. 6.

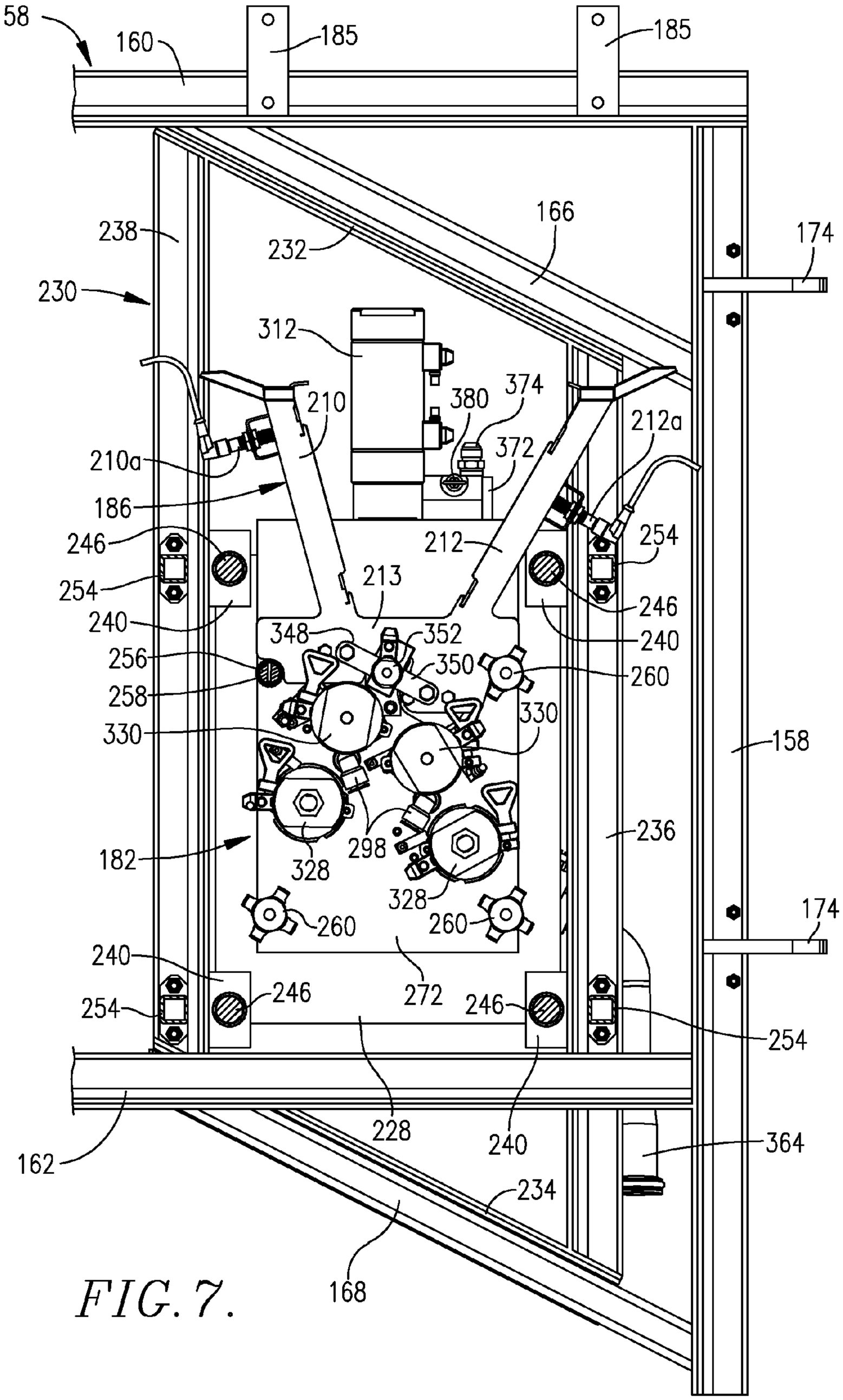
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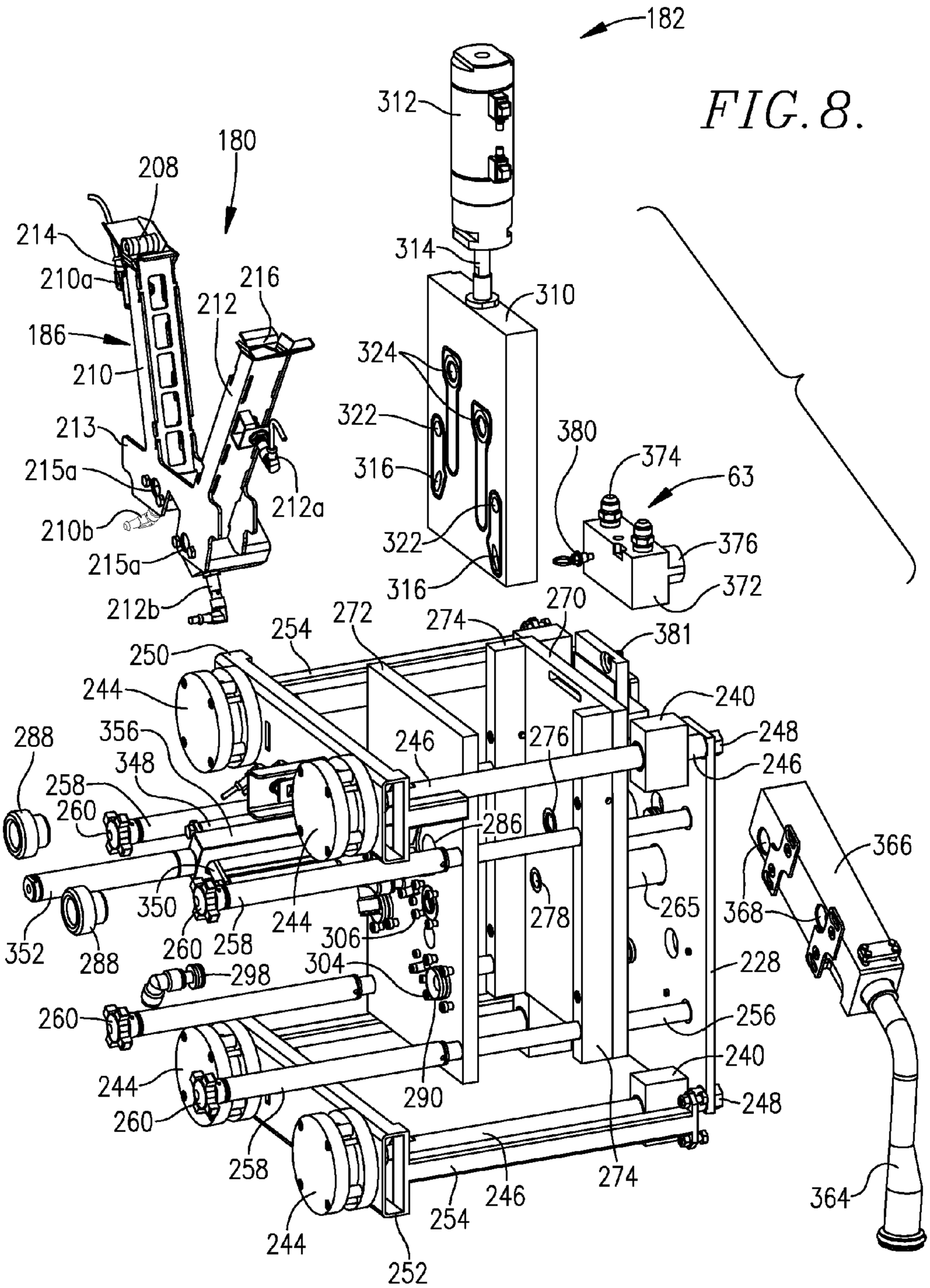
FIG. 7.

FIG. 8.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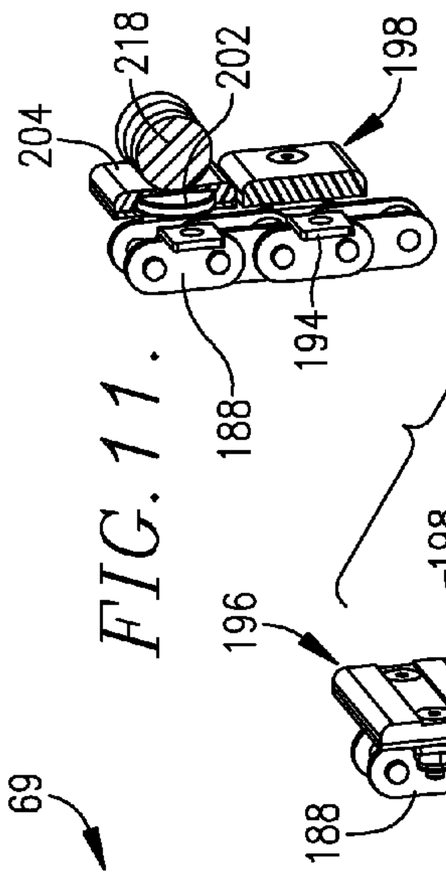

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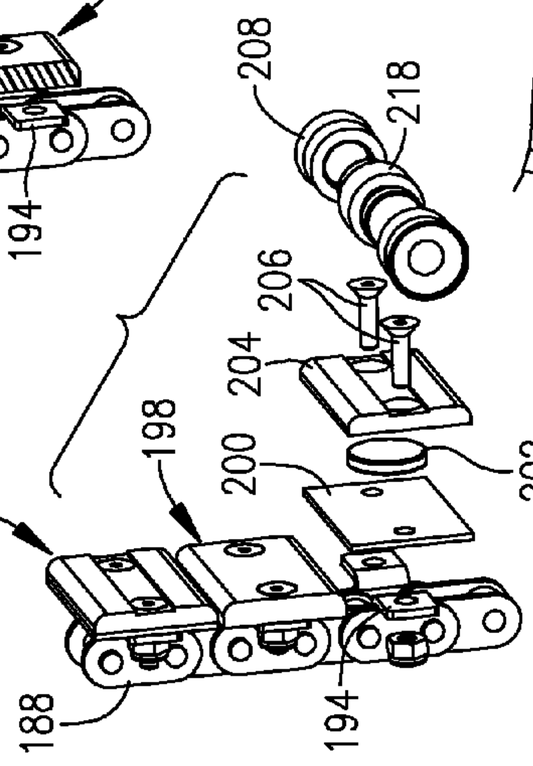

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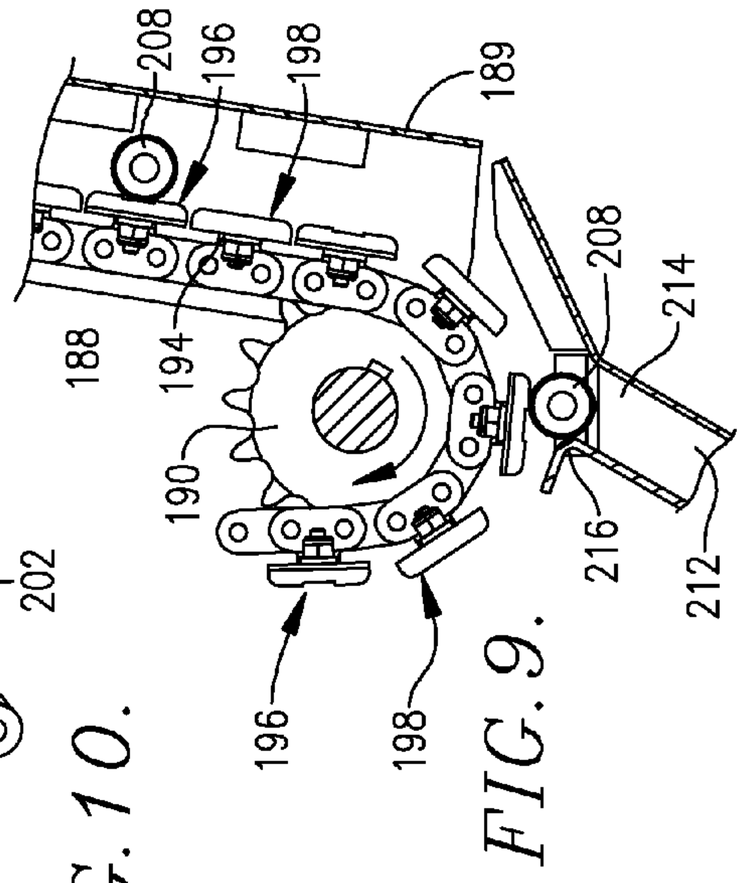

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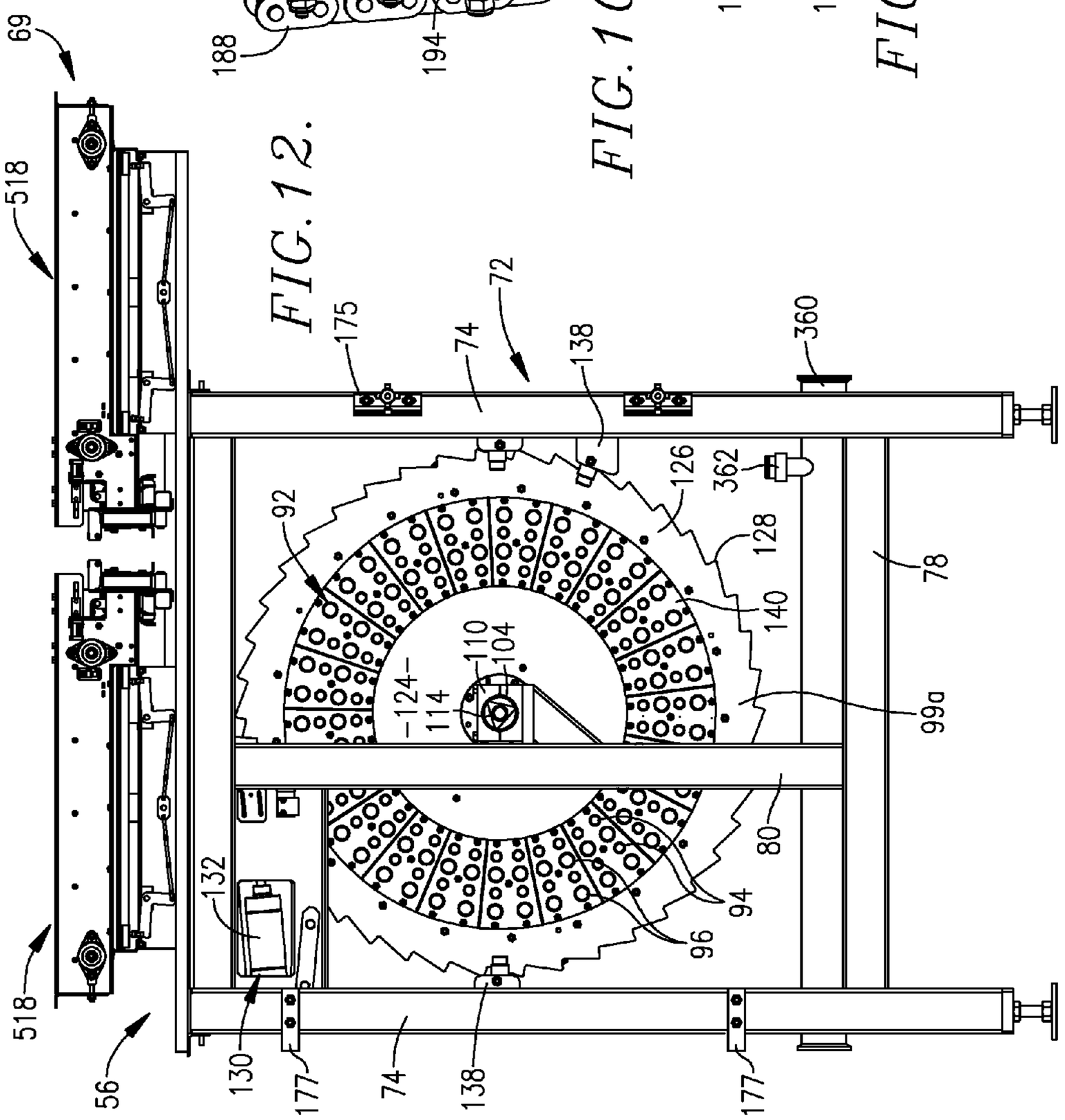

FIG. 12.

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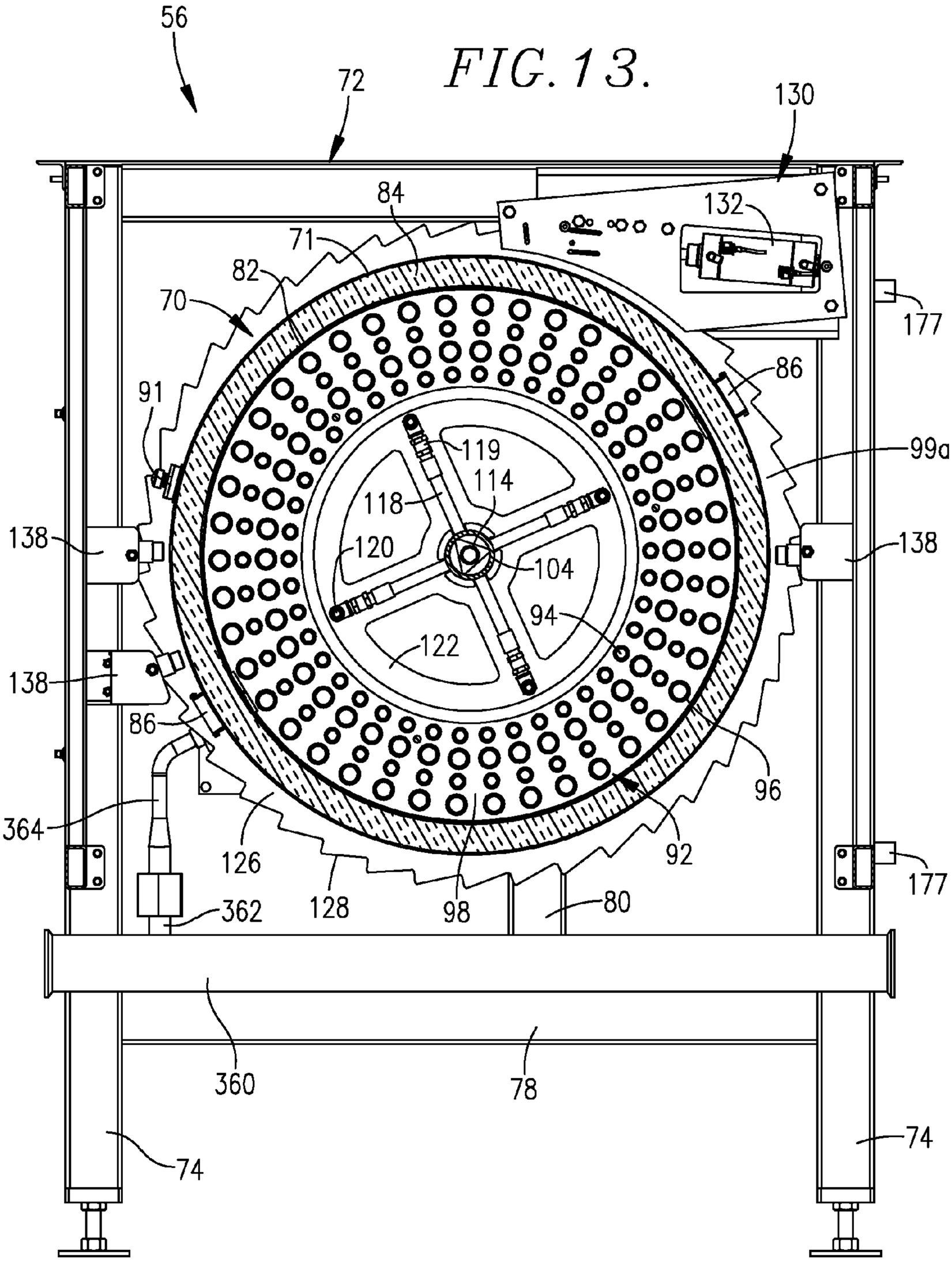
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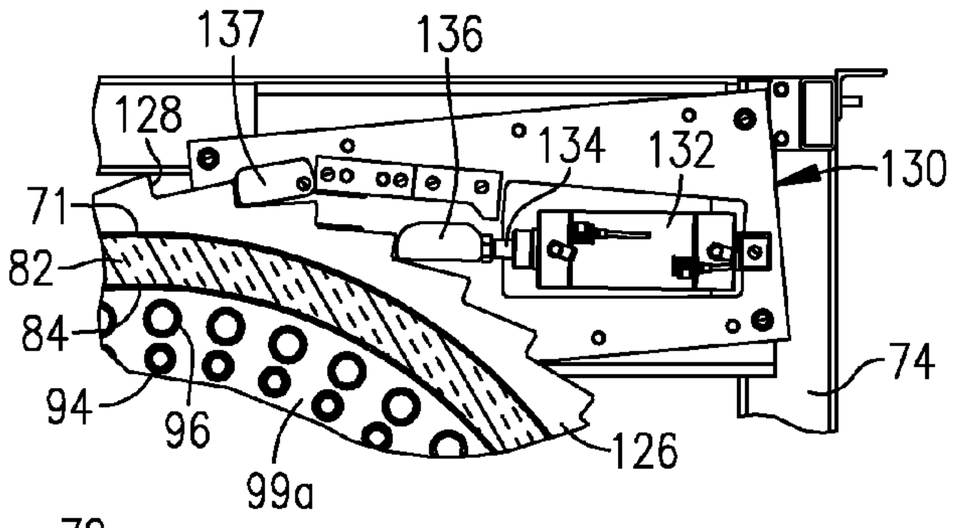
FIG. 15.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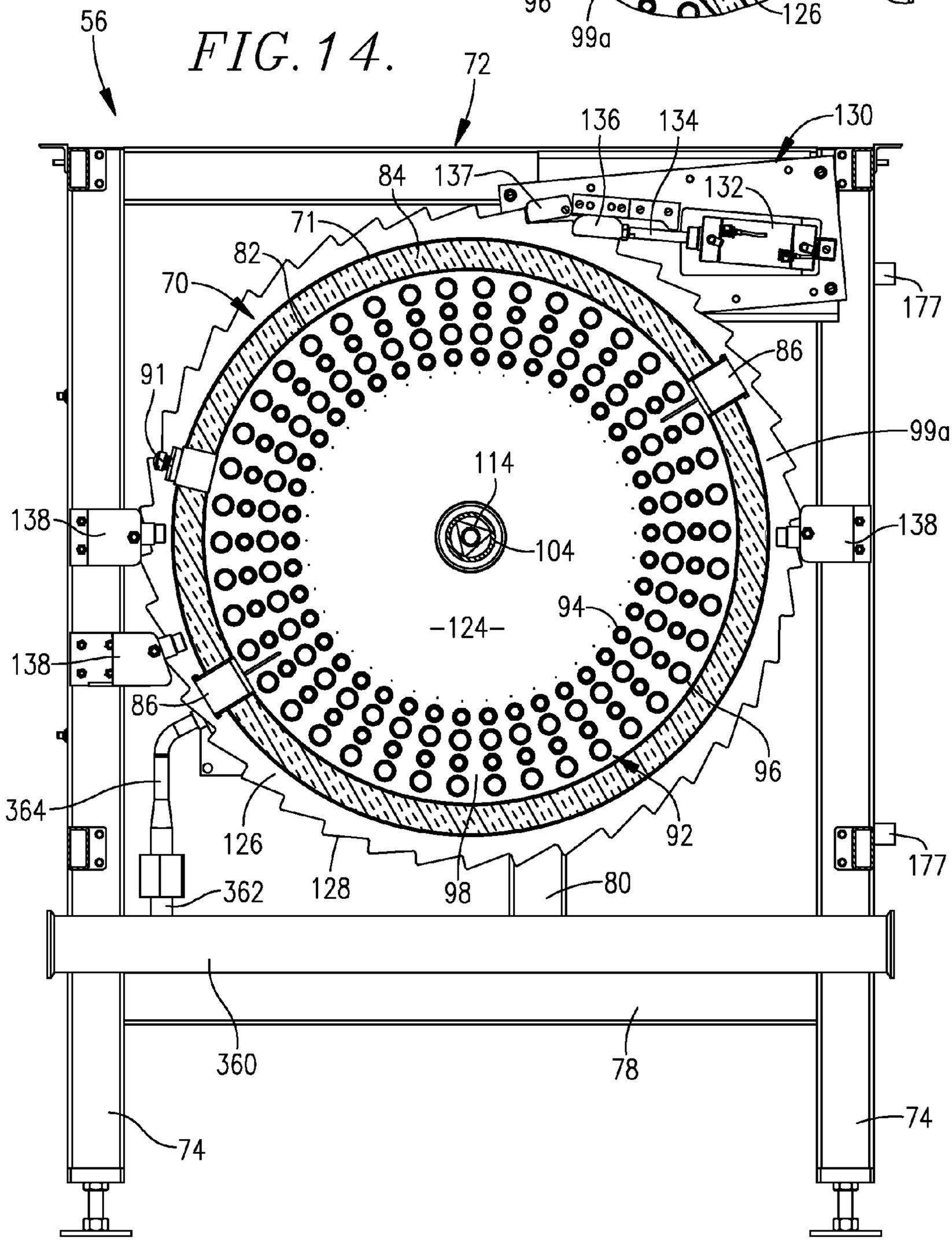
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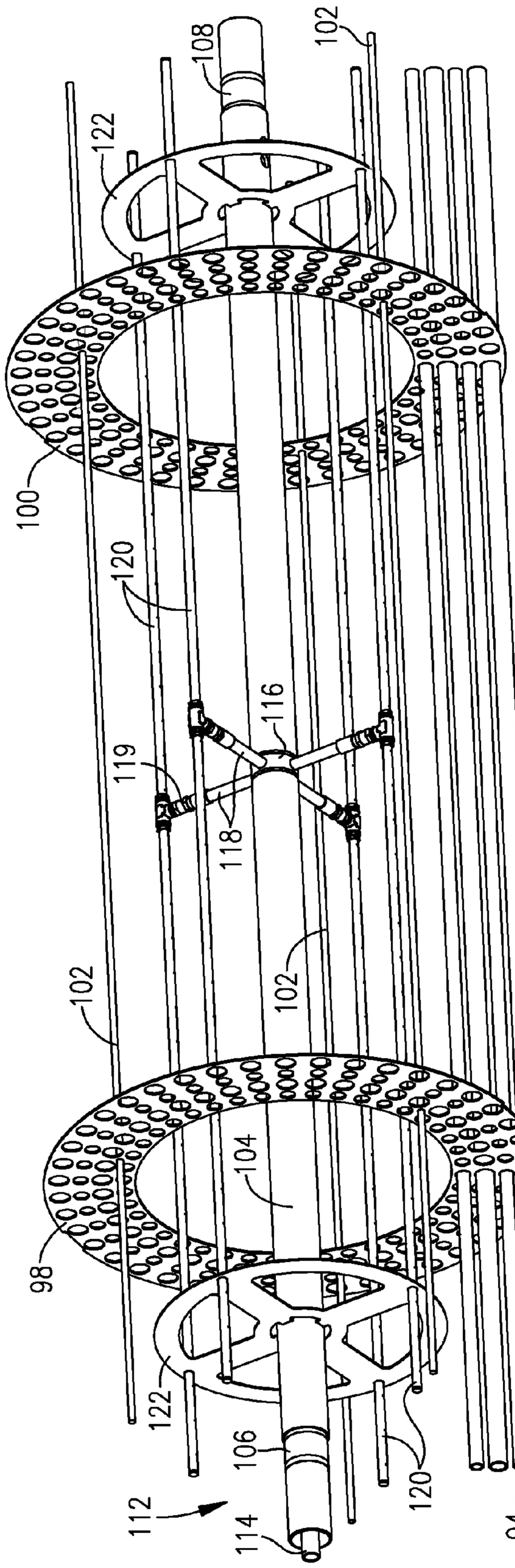
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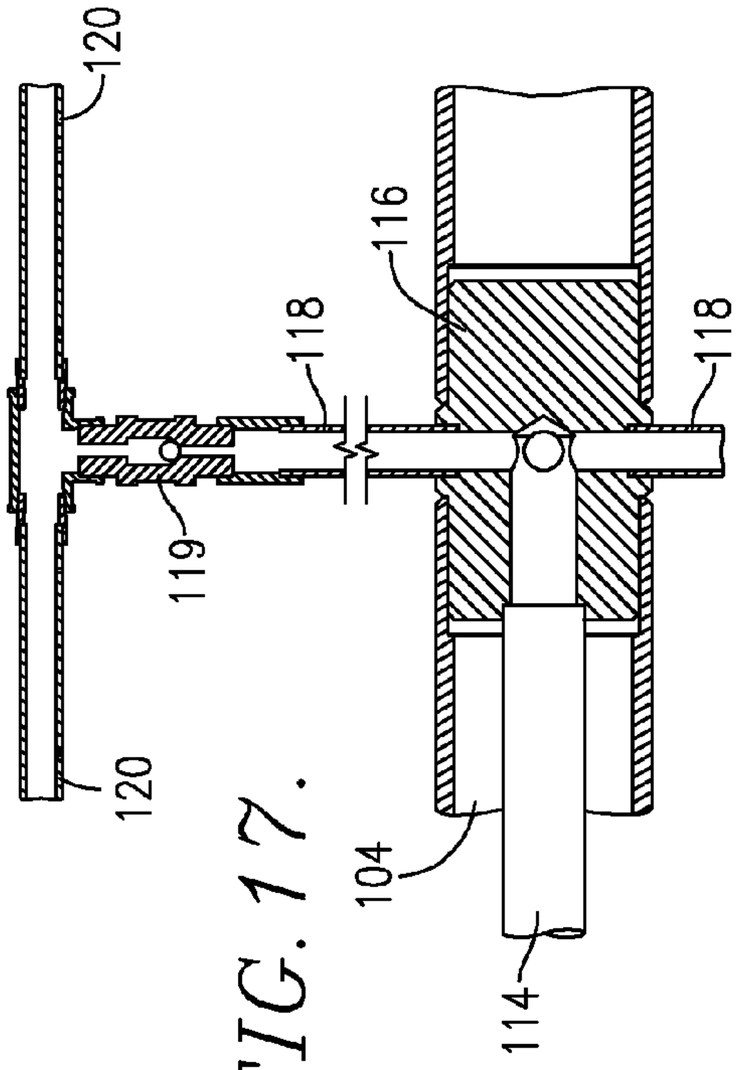
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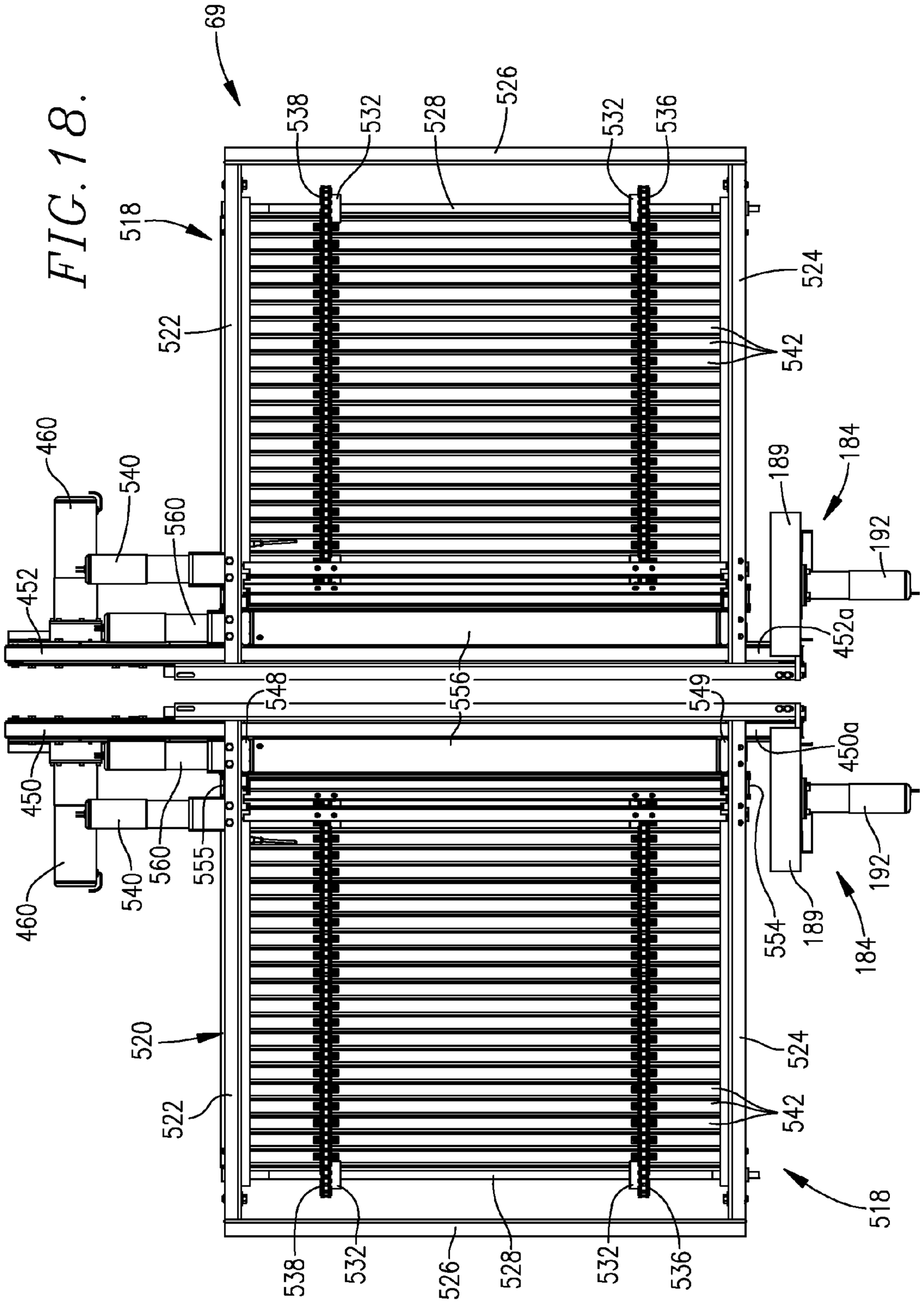
FIG. 17.

FIG. 18.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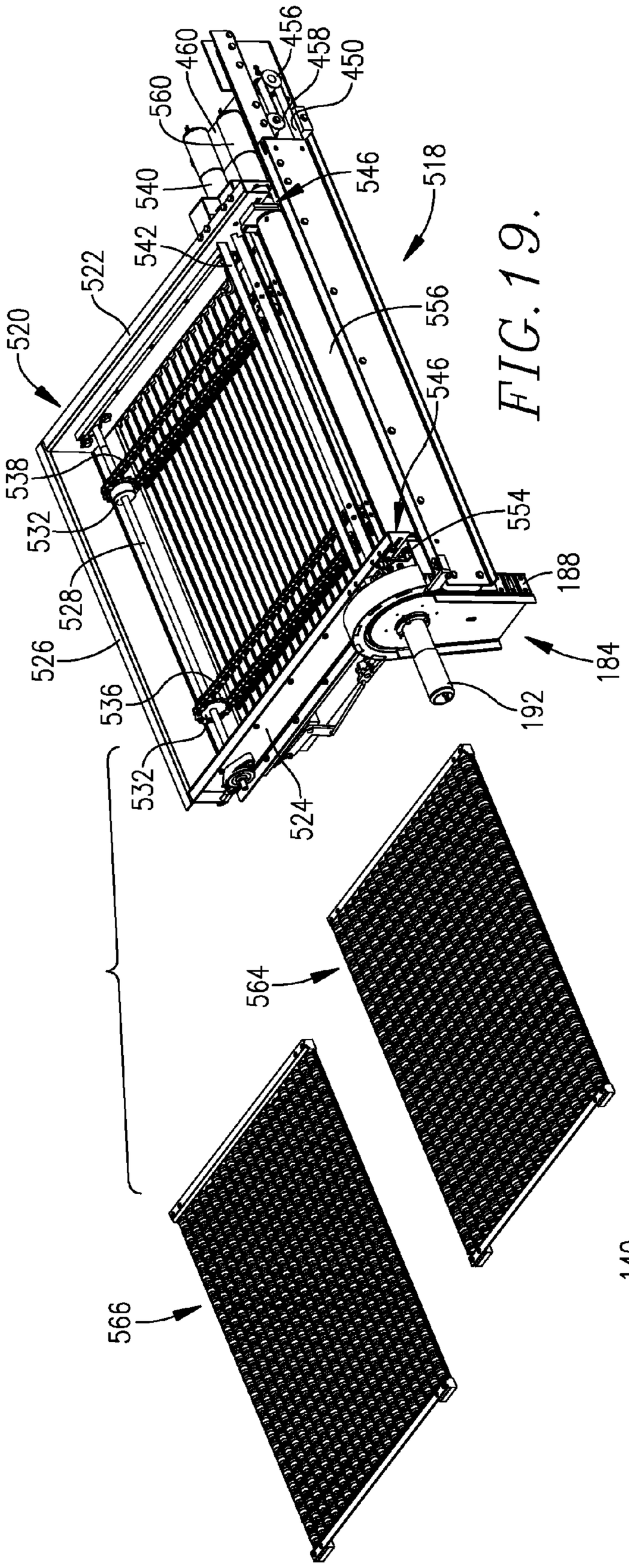

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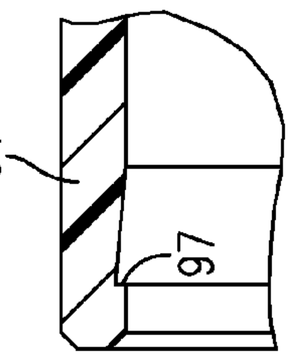

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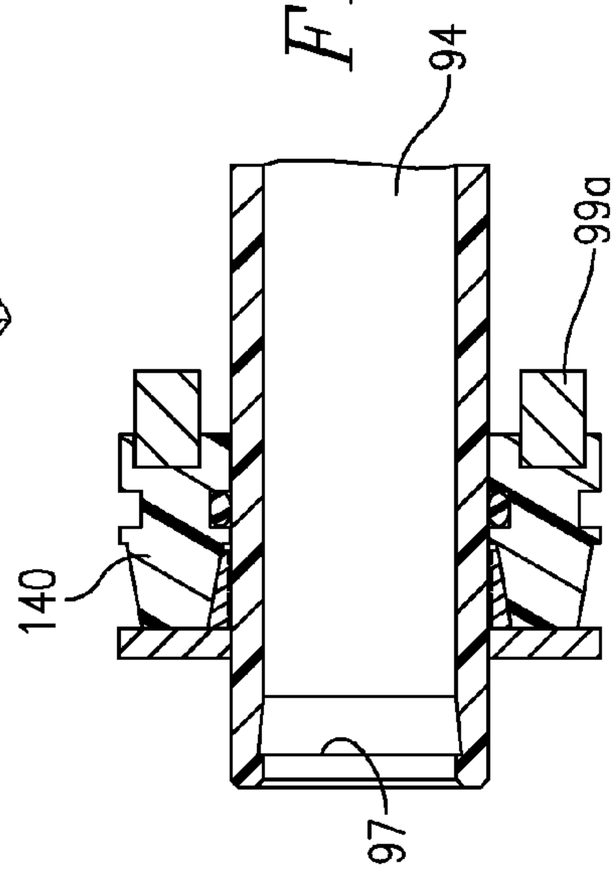

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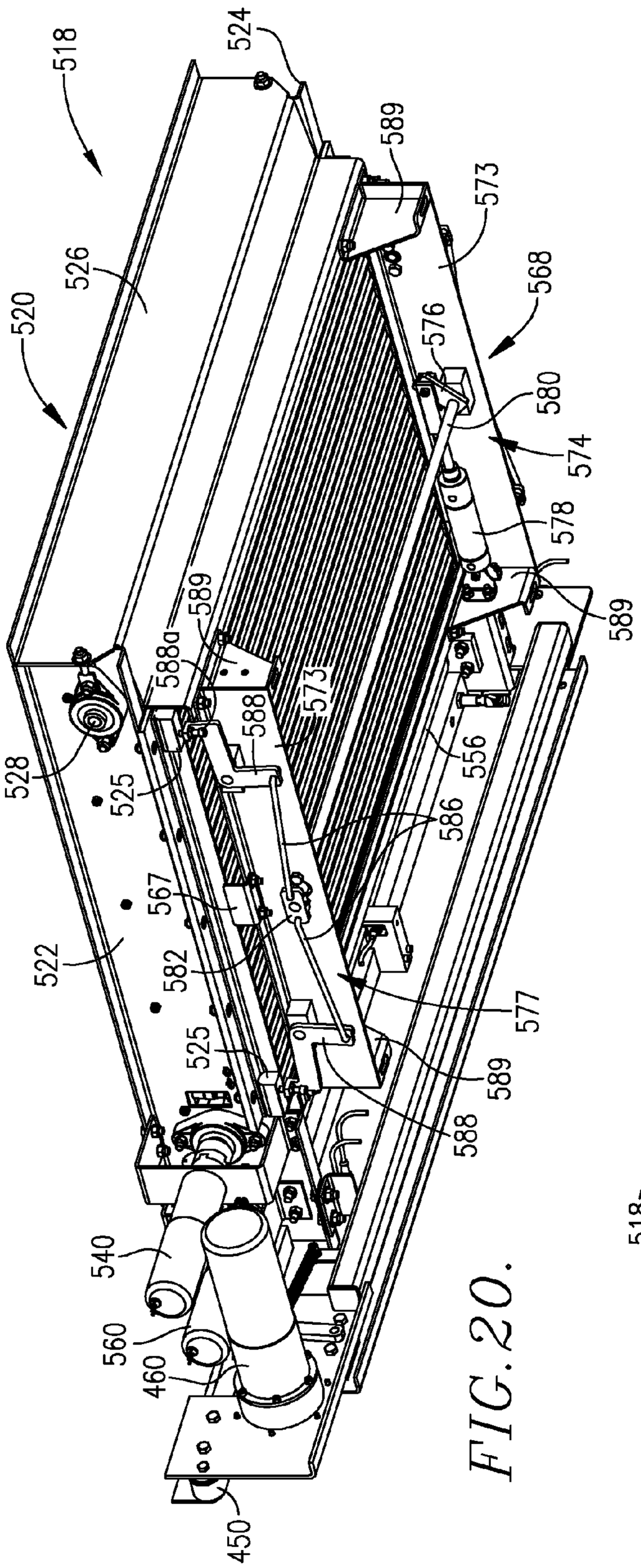
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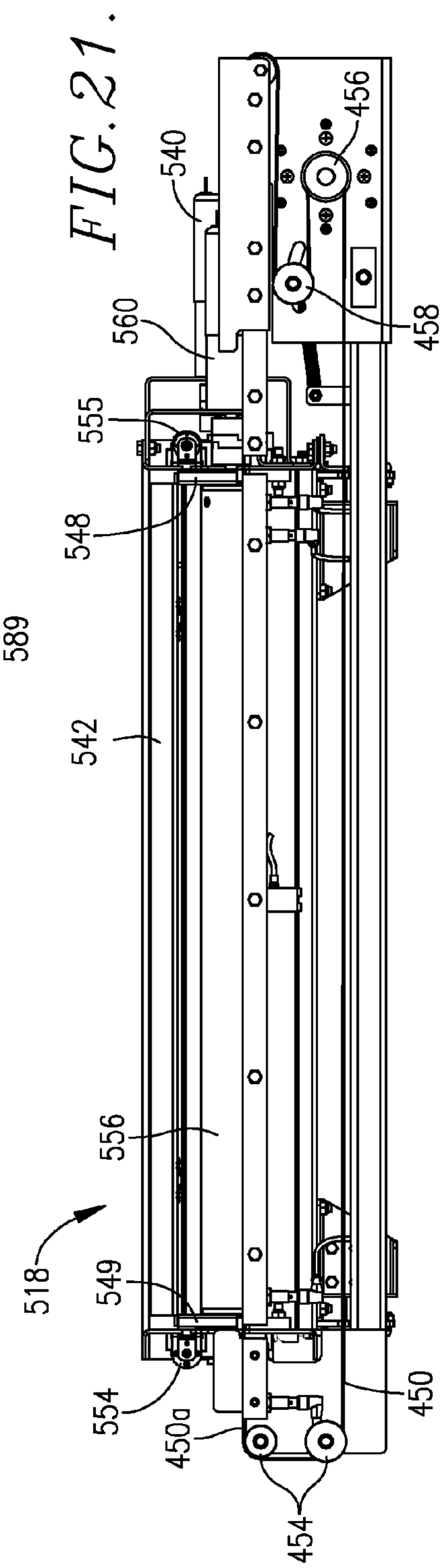
FIG. 20.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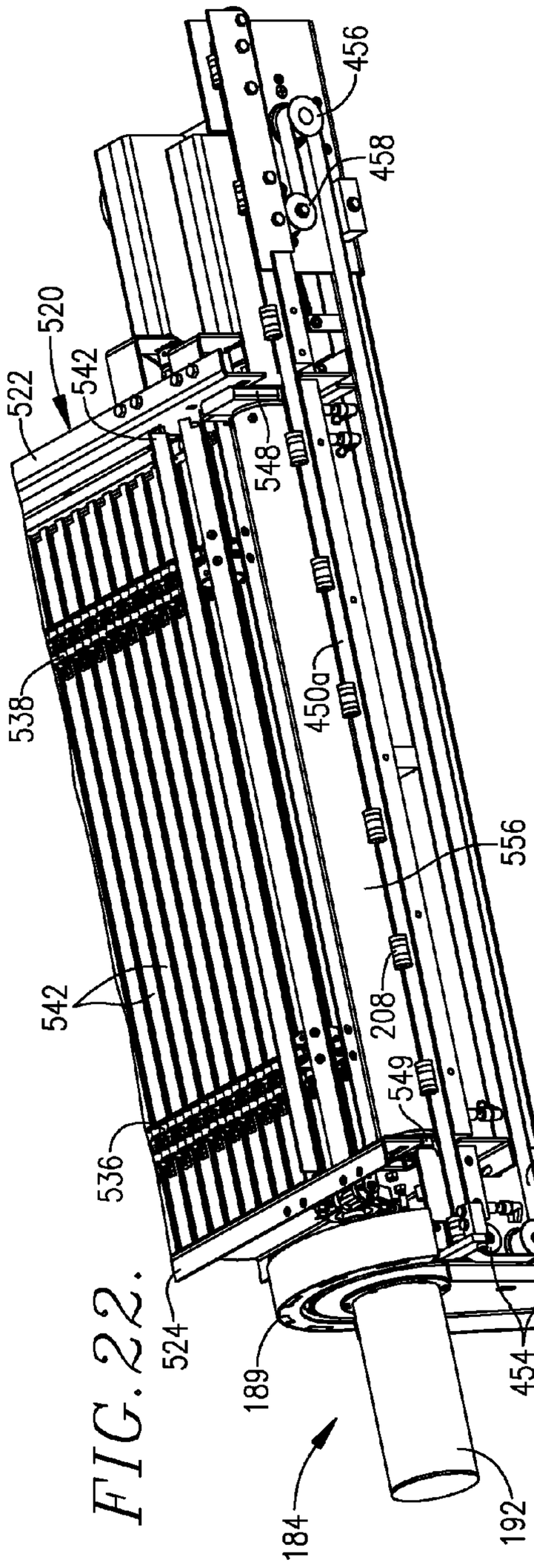
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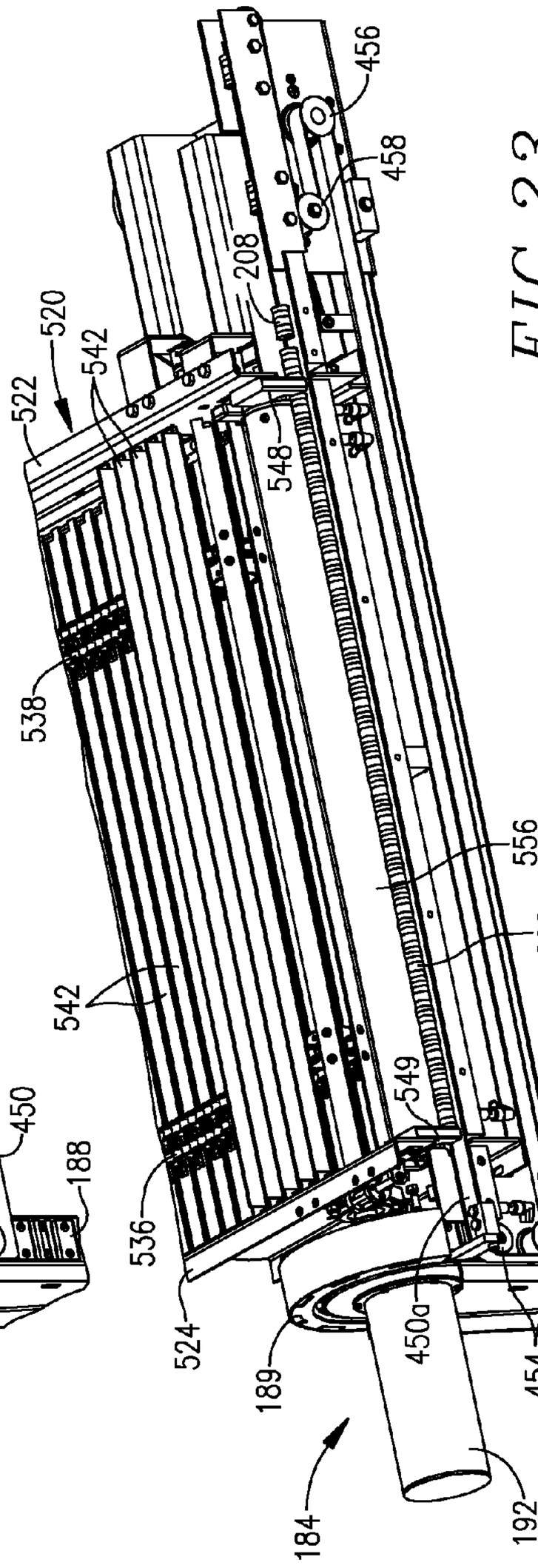
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FIG. 23.

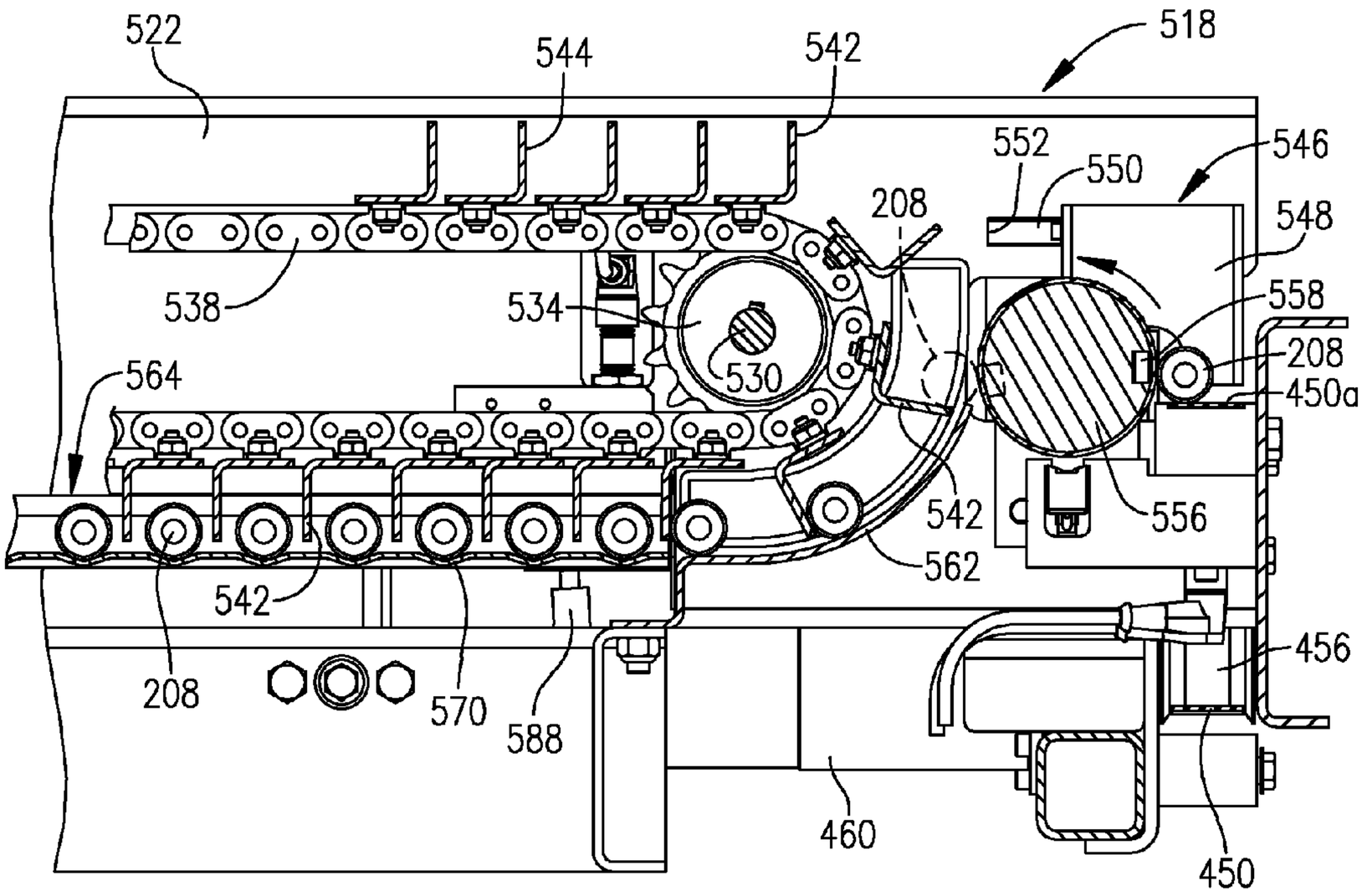
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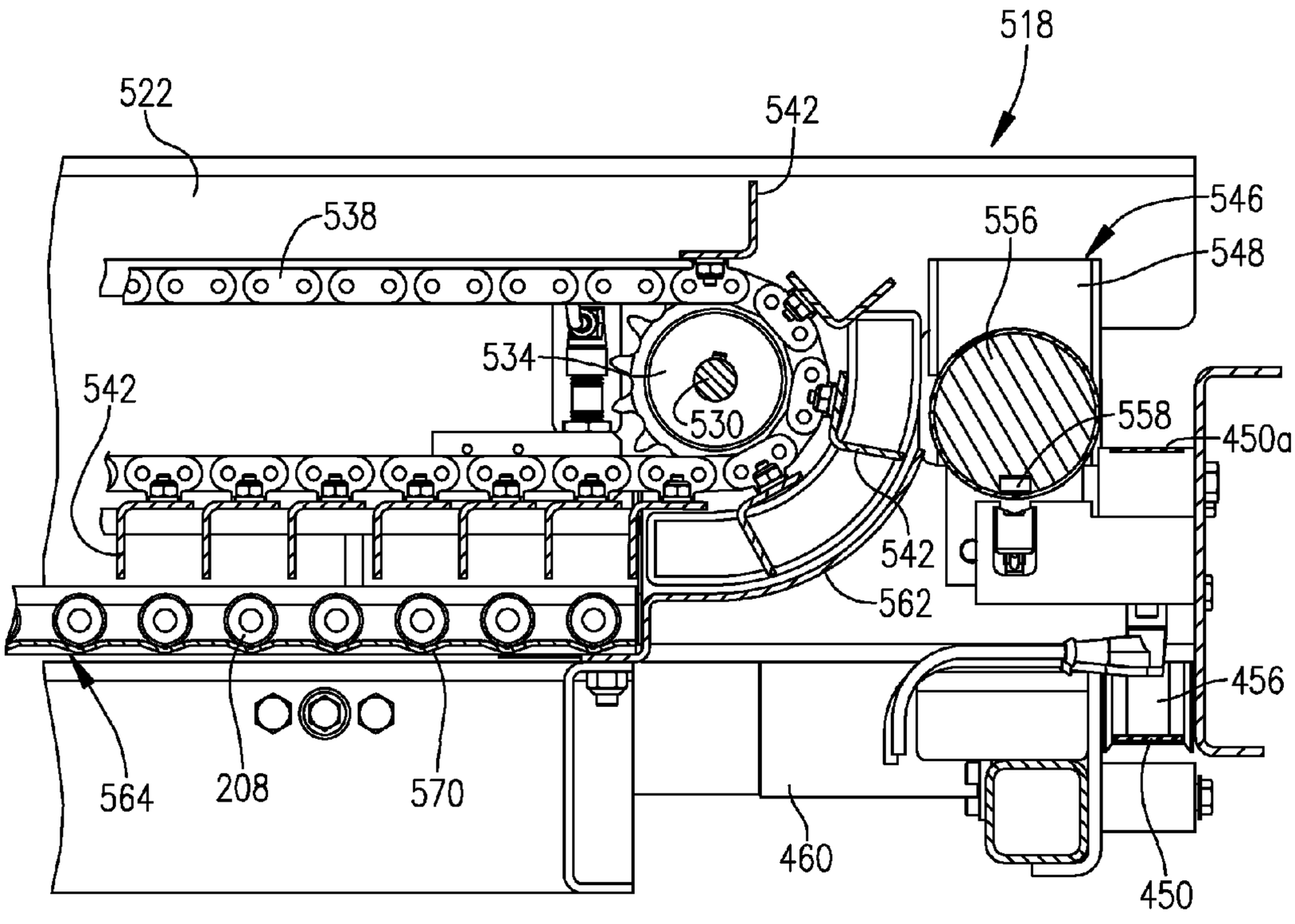
FIG. 24.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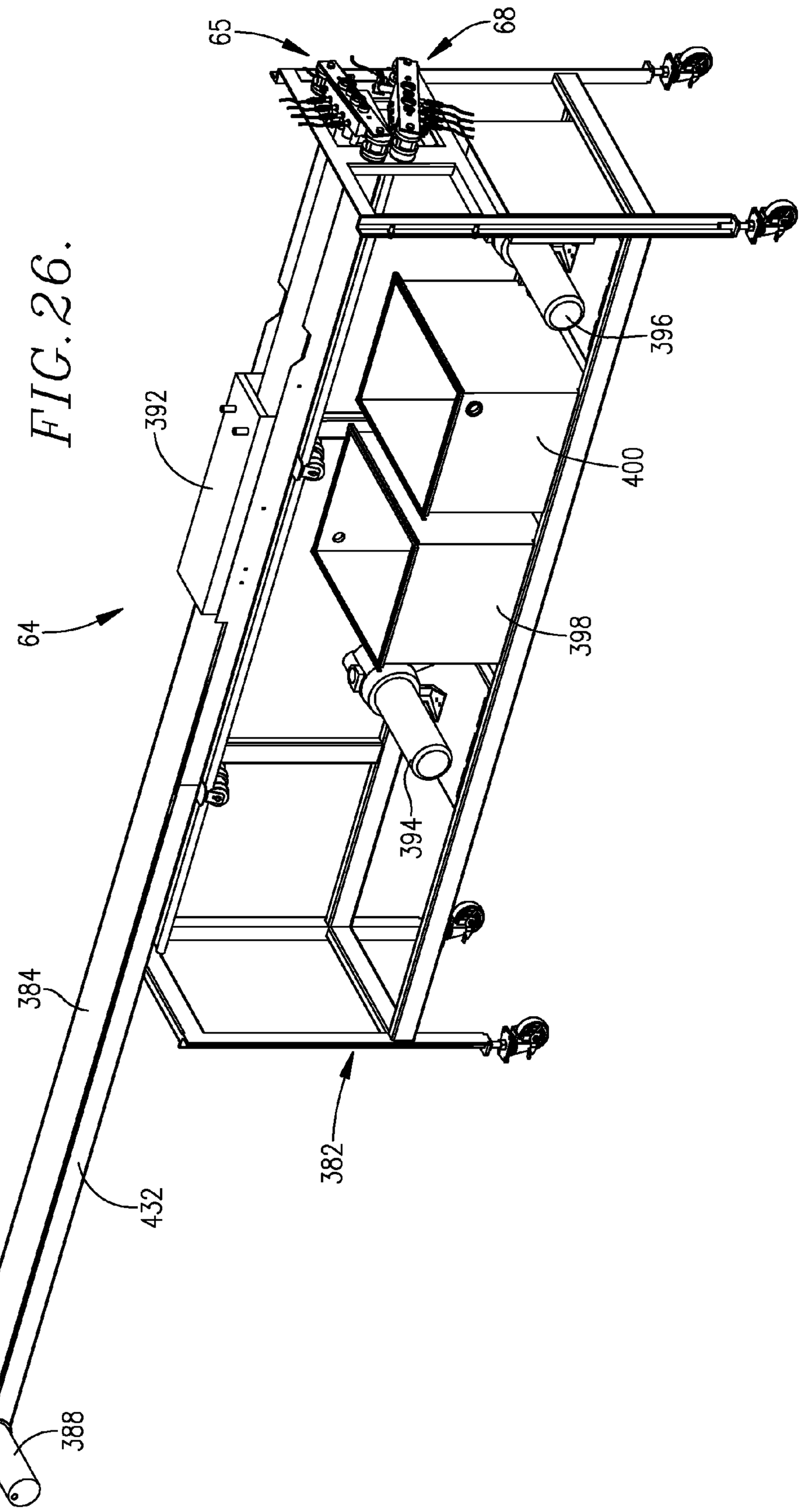

FIG. 26.

FIG. 27.

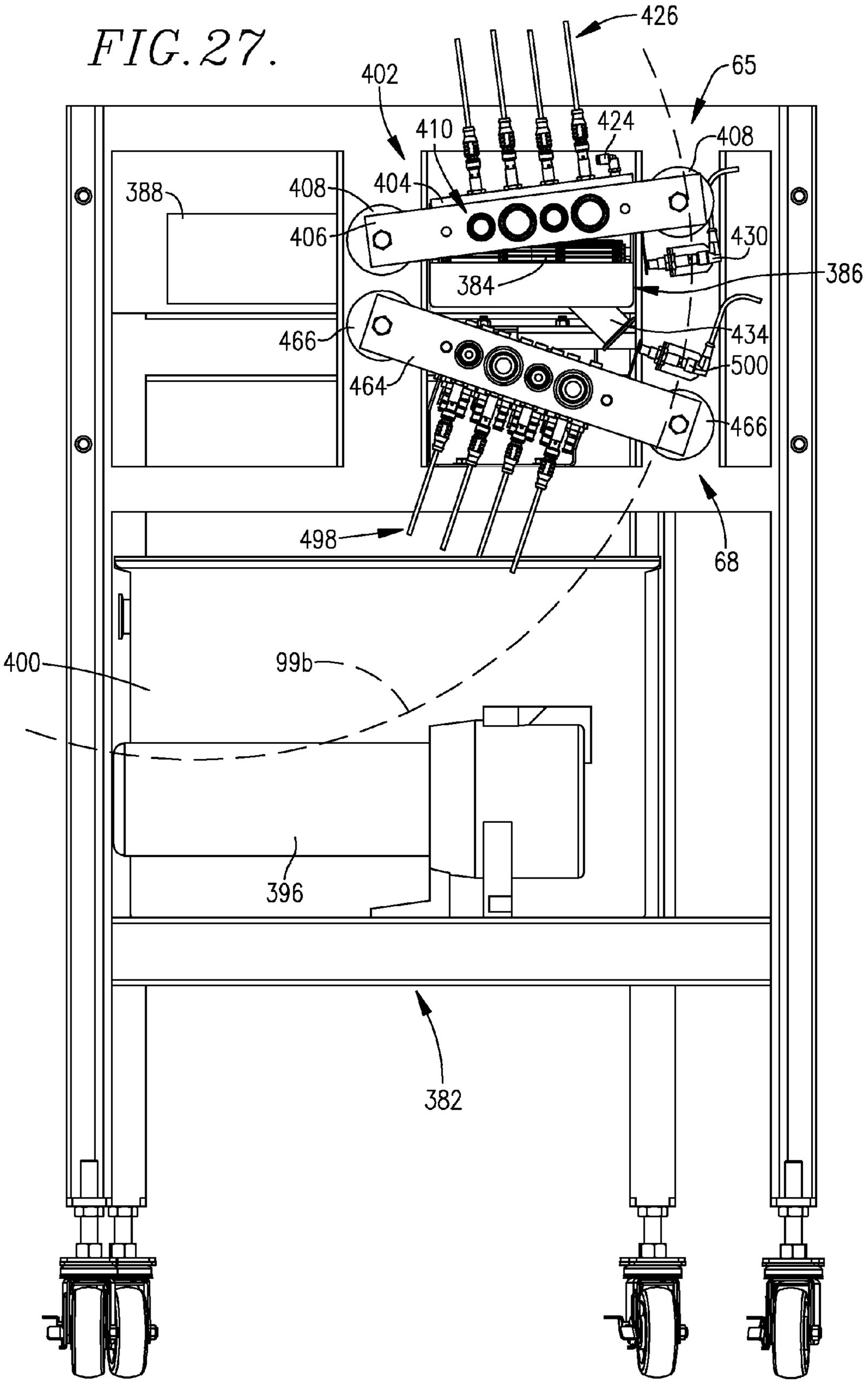
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FIG. 28.

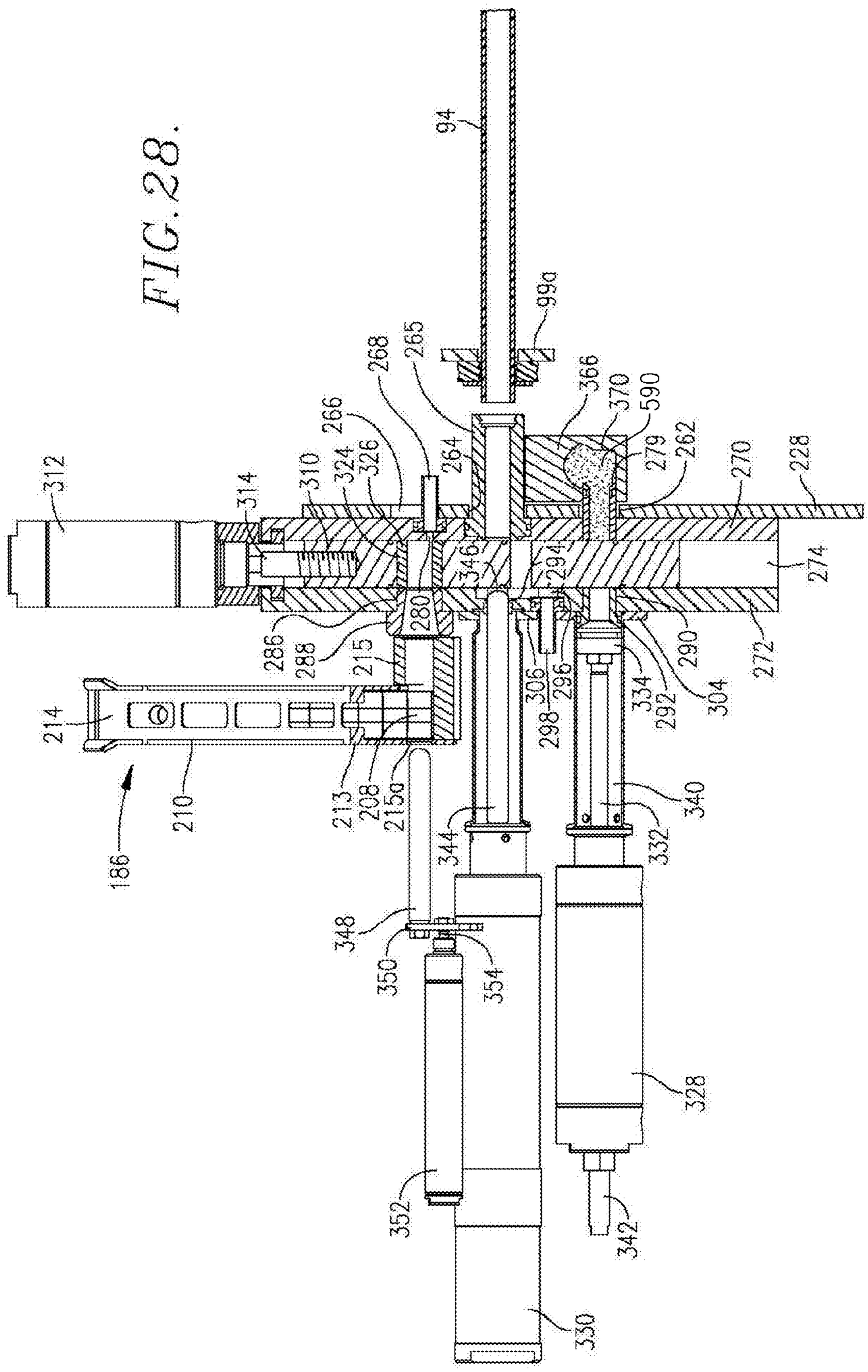
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FIG. 29.

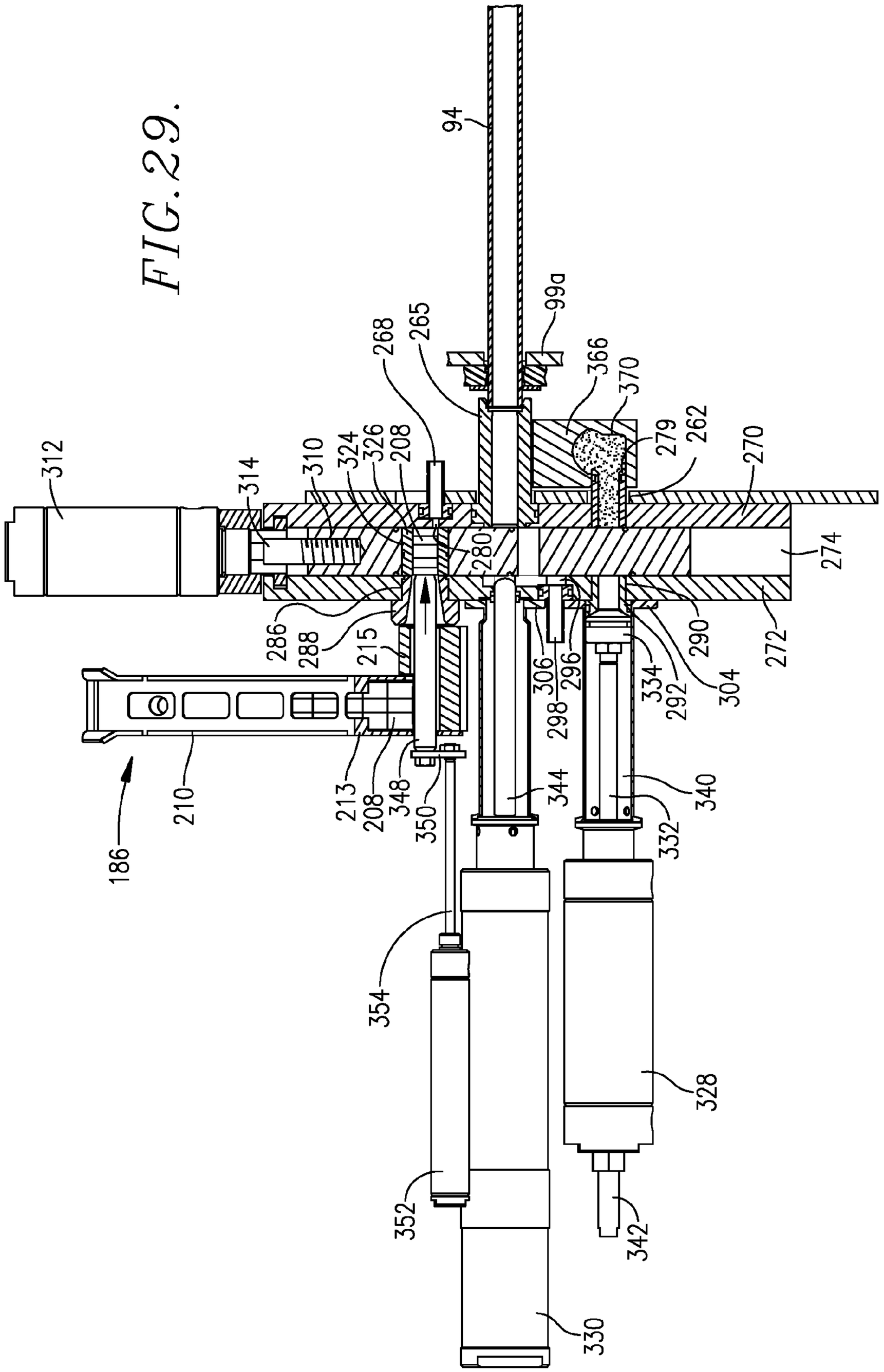
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FIG. 30.

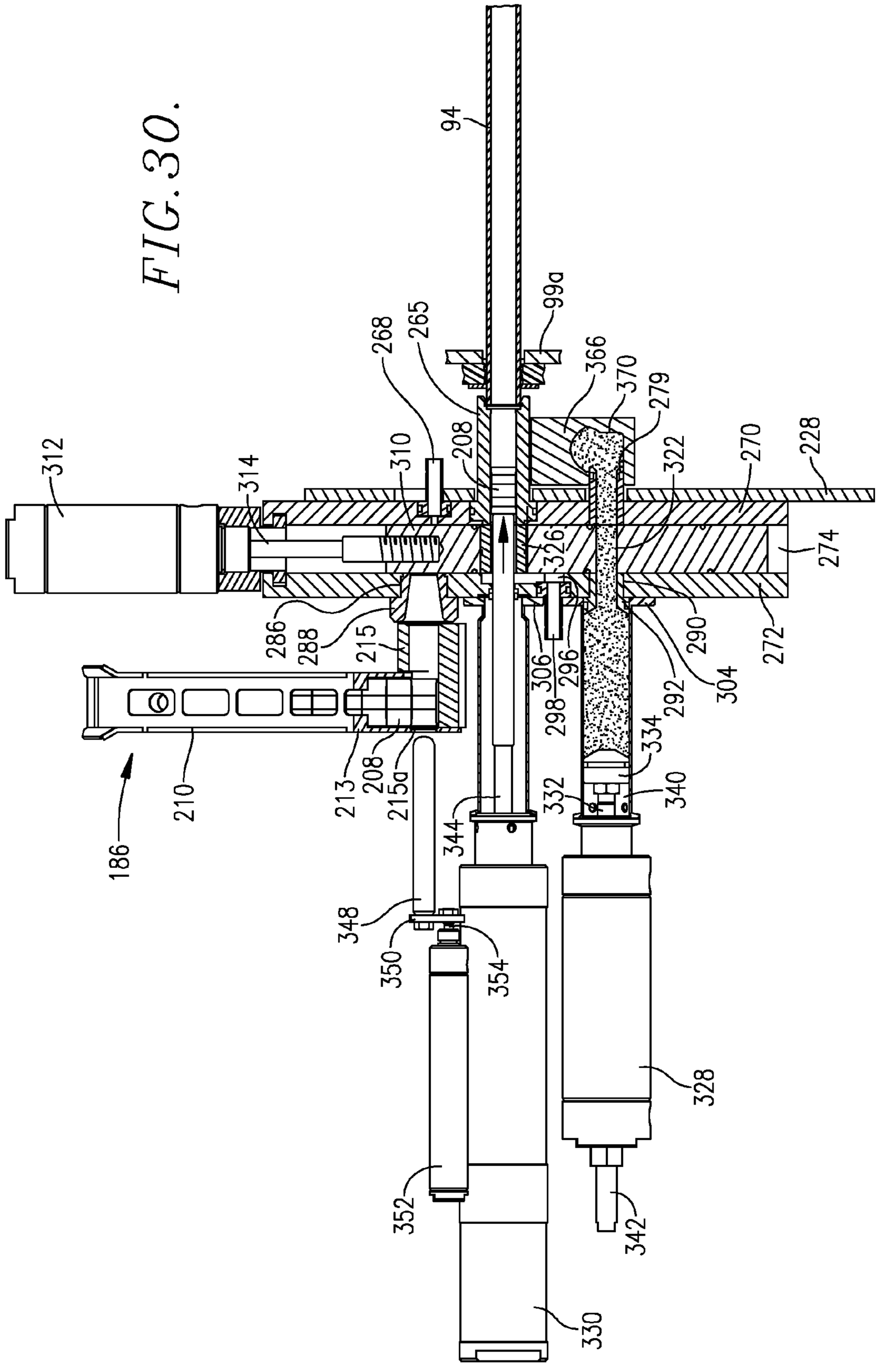
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FIG. 31.

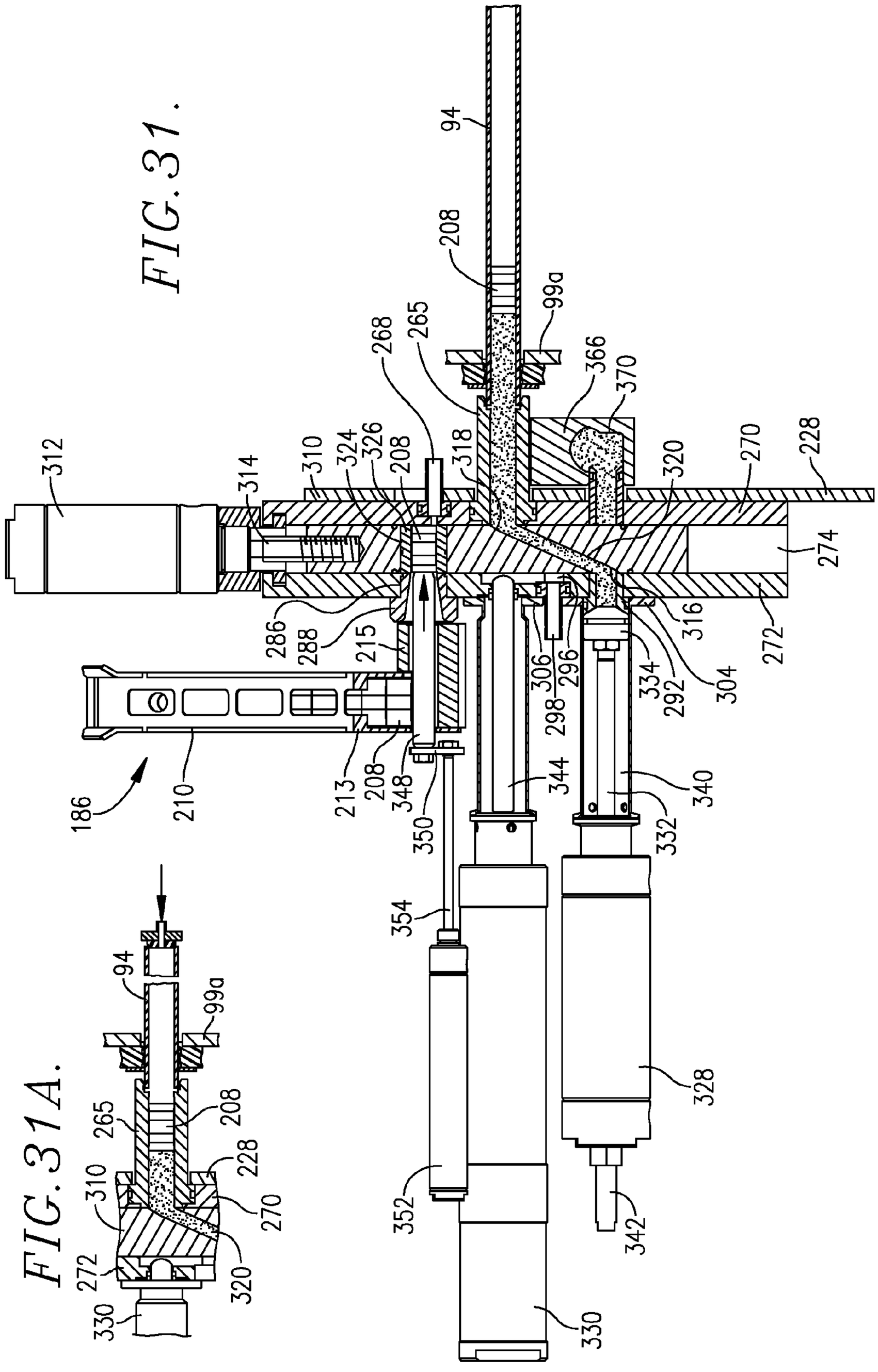

FIG. 31A.

FIG. 32.

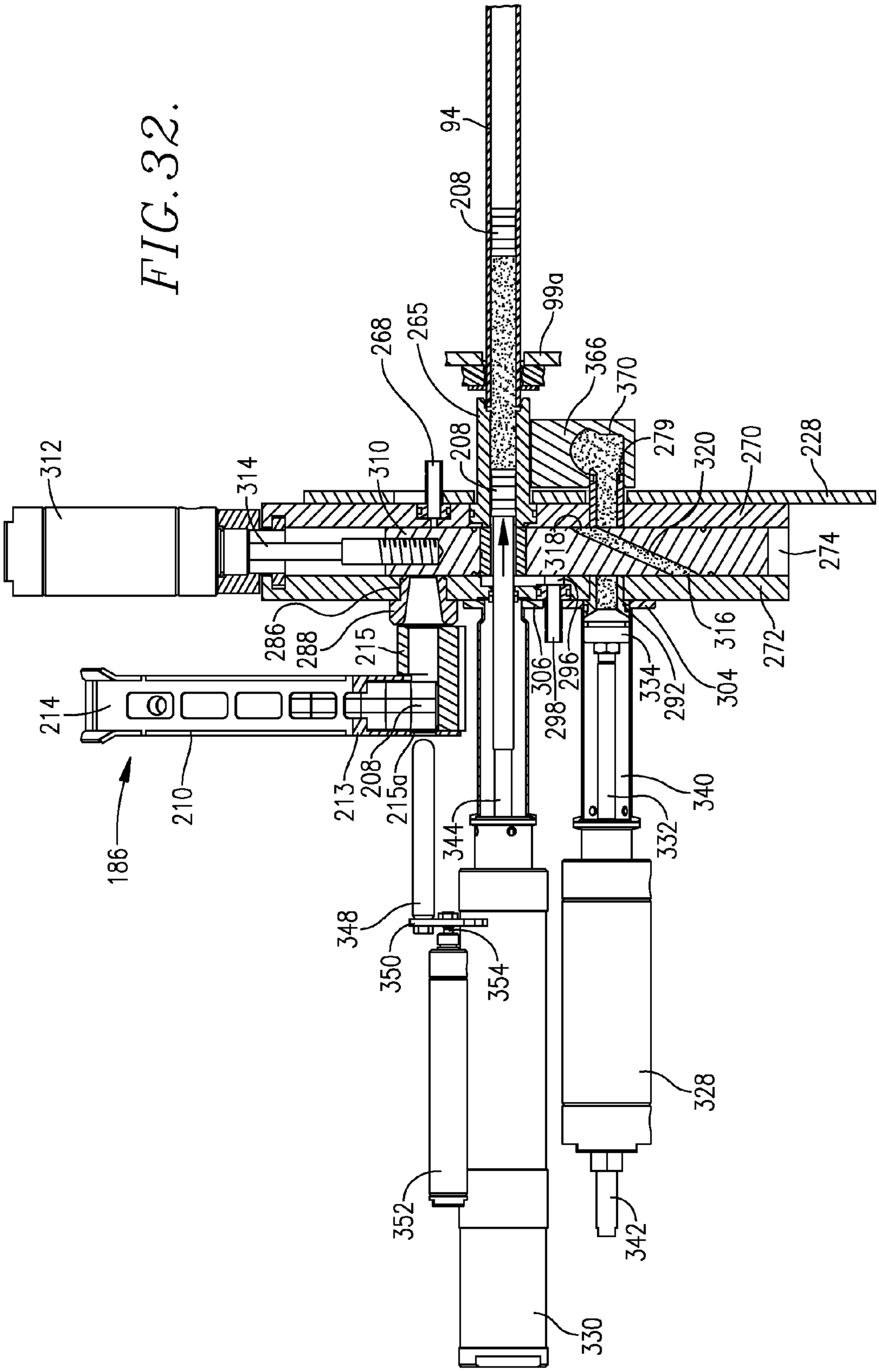
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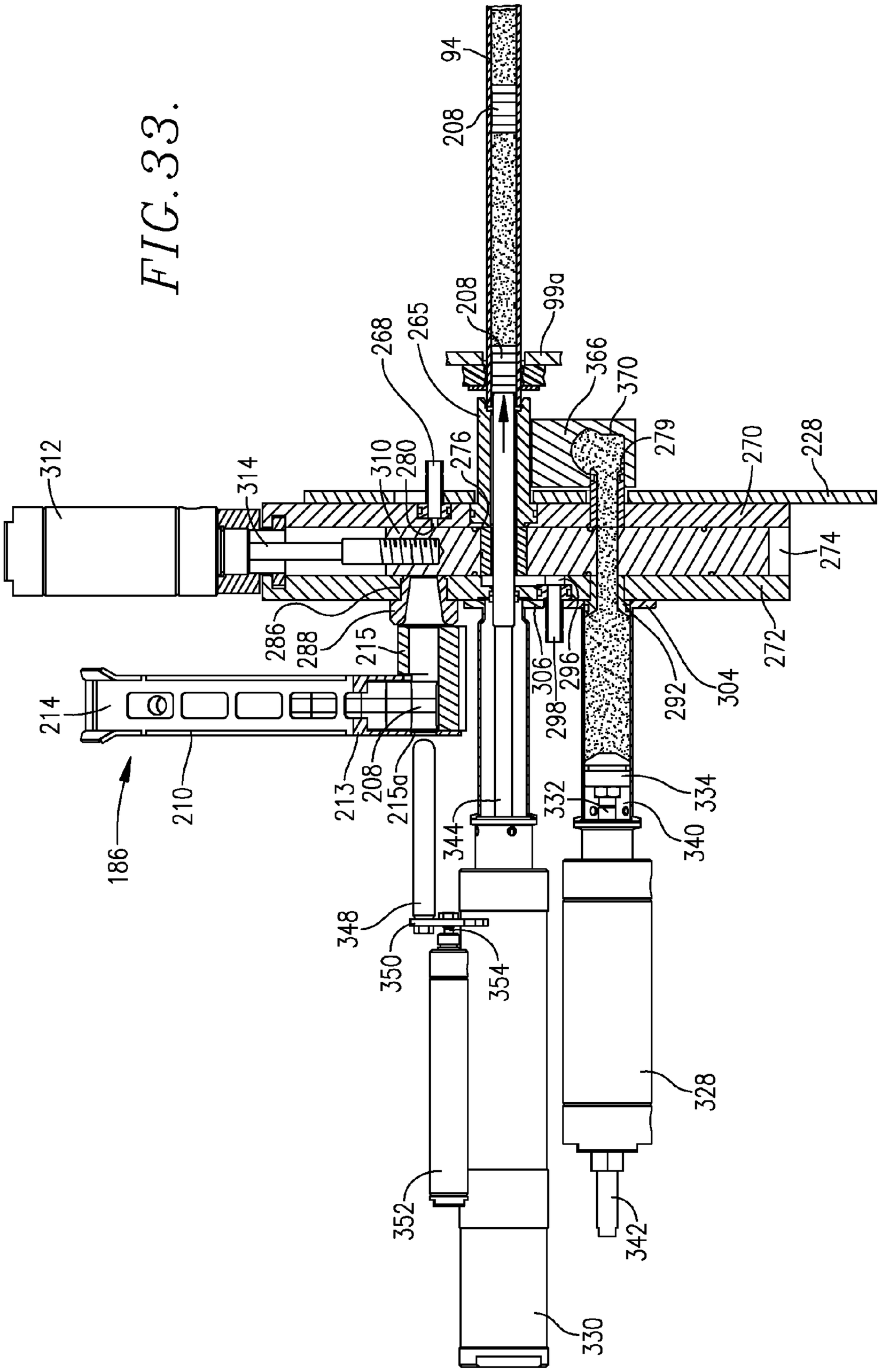
FIG. 33.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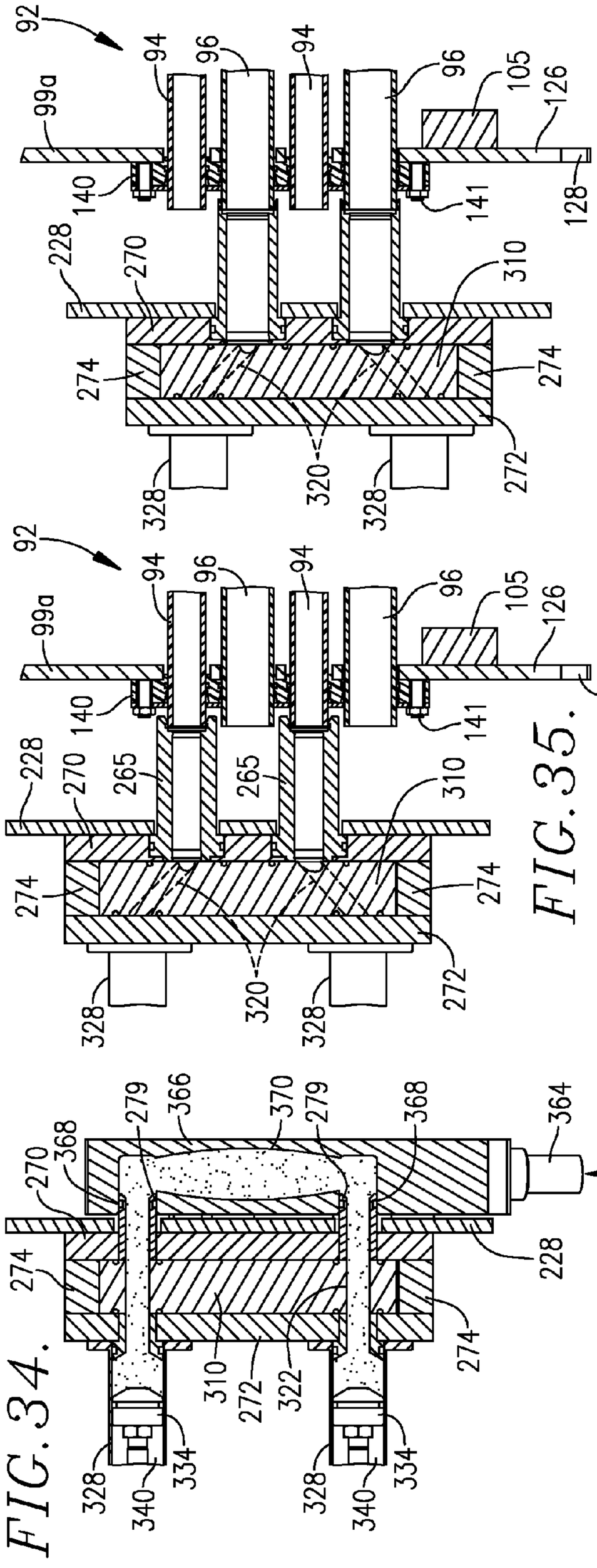

FIG. 35.

FIG. 36.

FIG. 34.

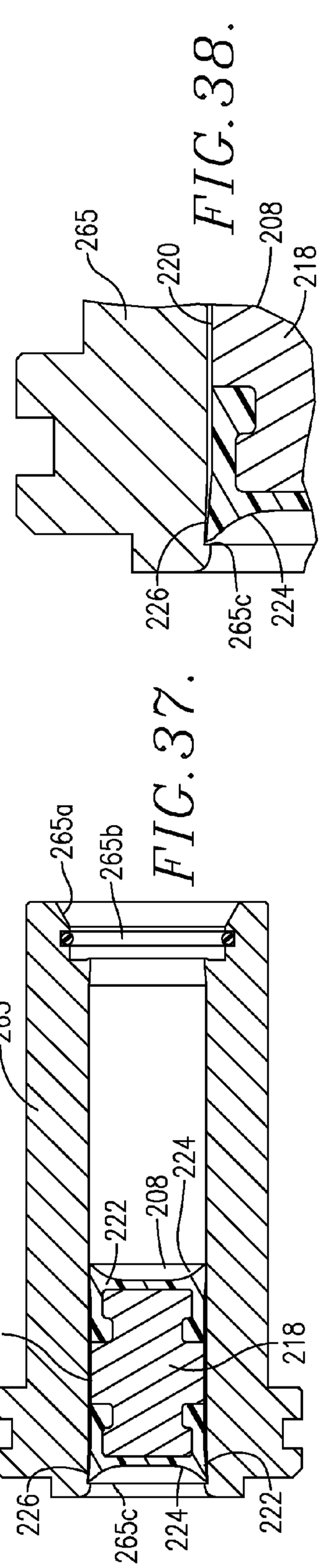

FIG. 38.

FIG. 37.

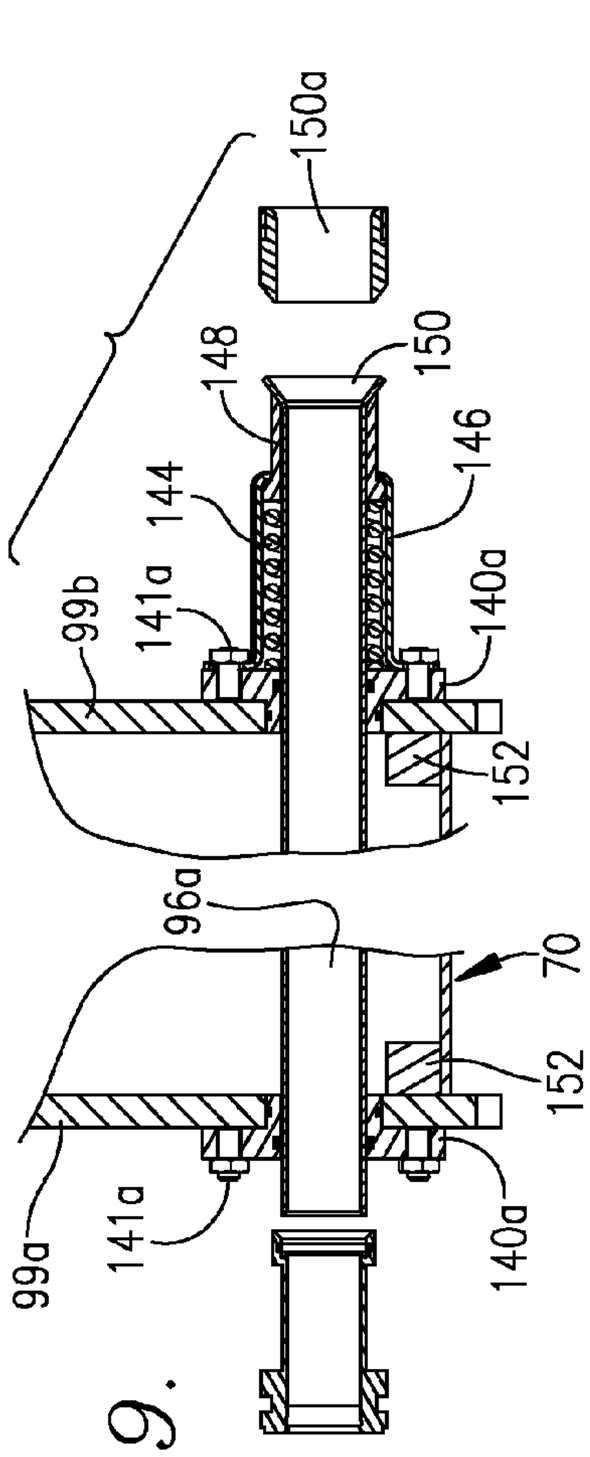
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FIG. 49.

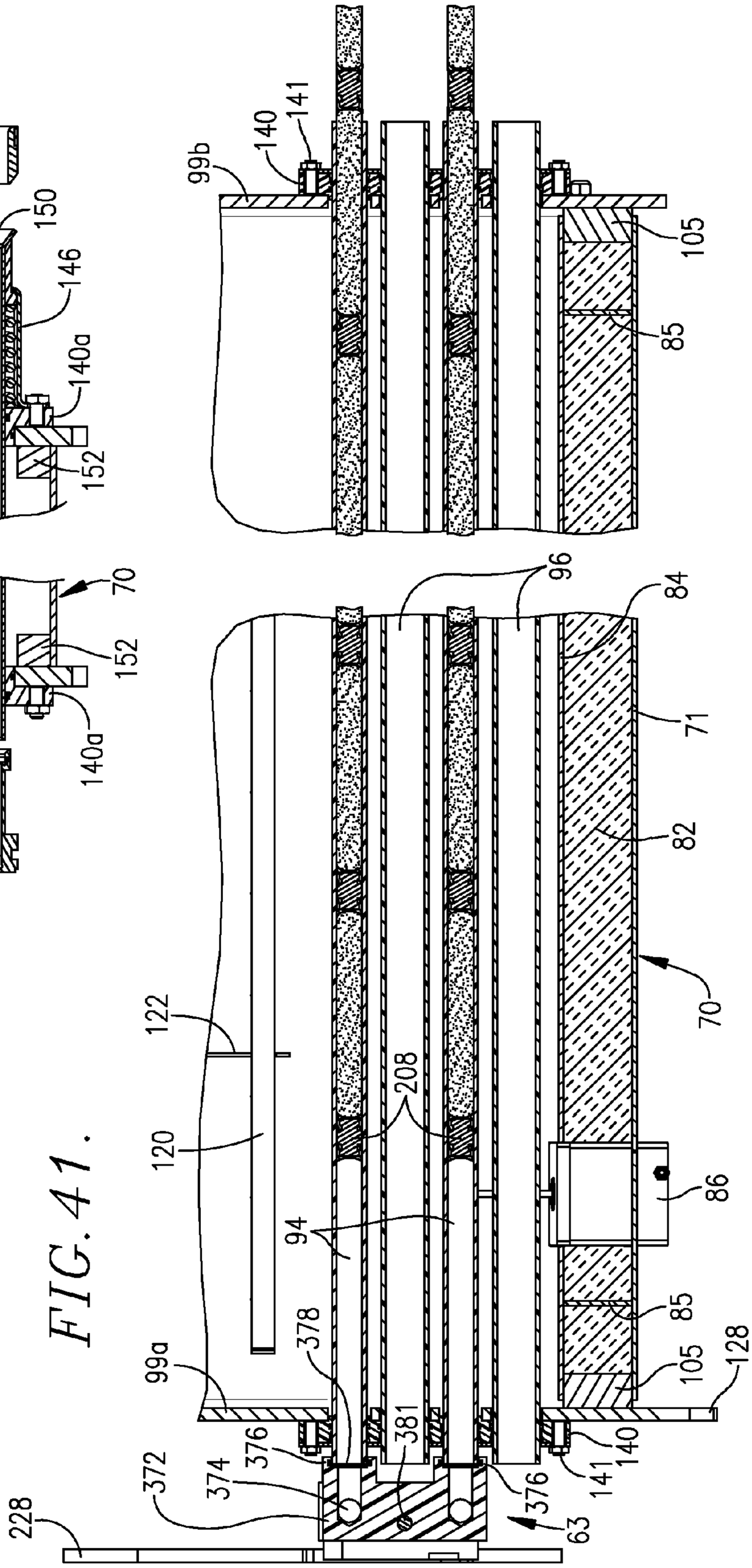
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FIG. 41.

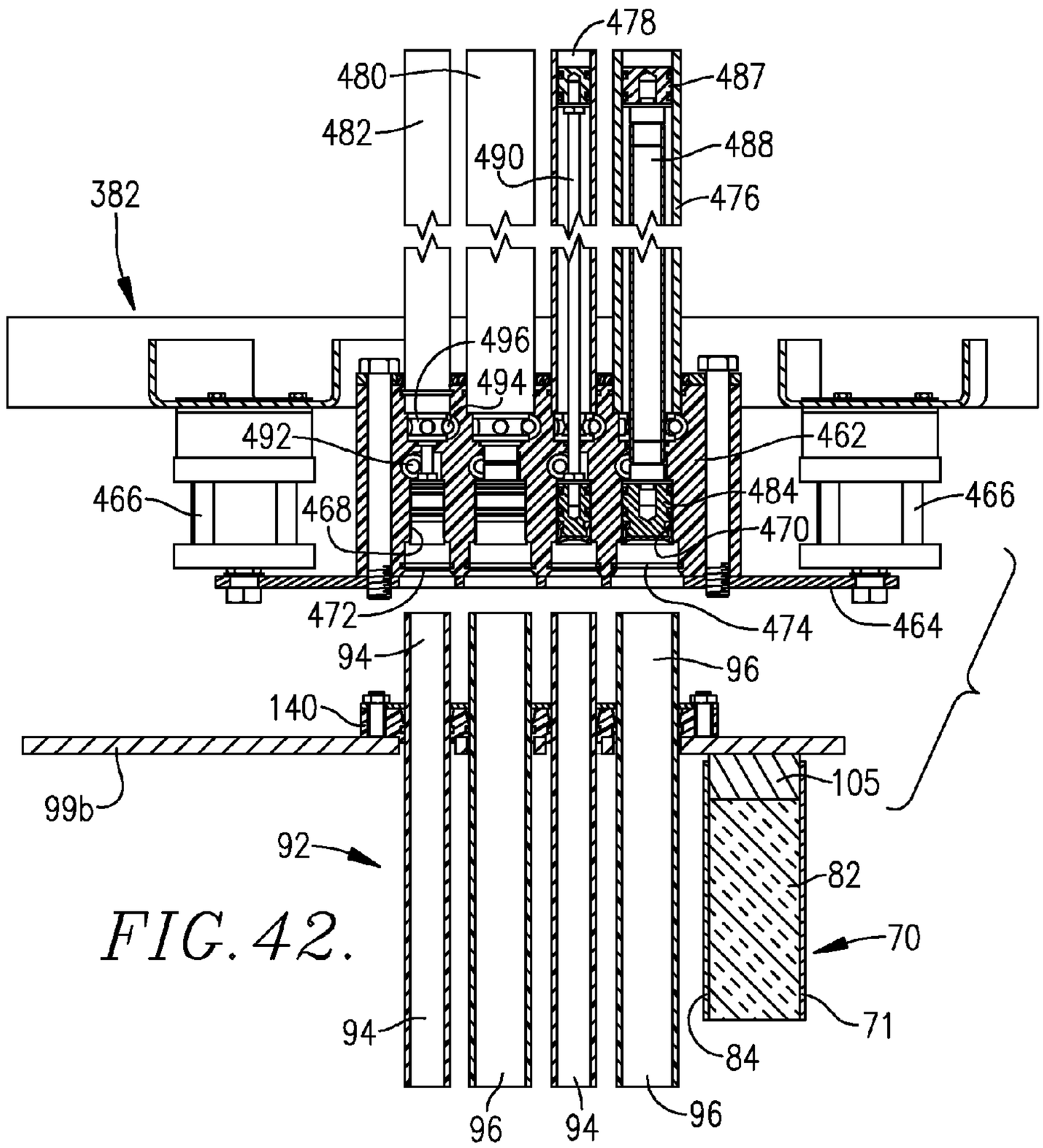
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FIG. 42.

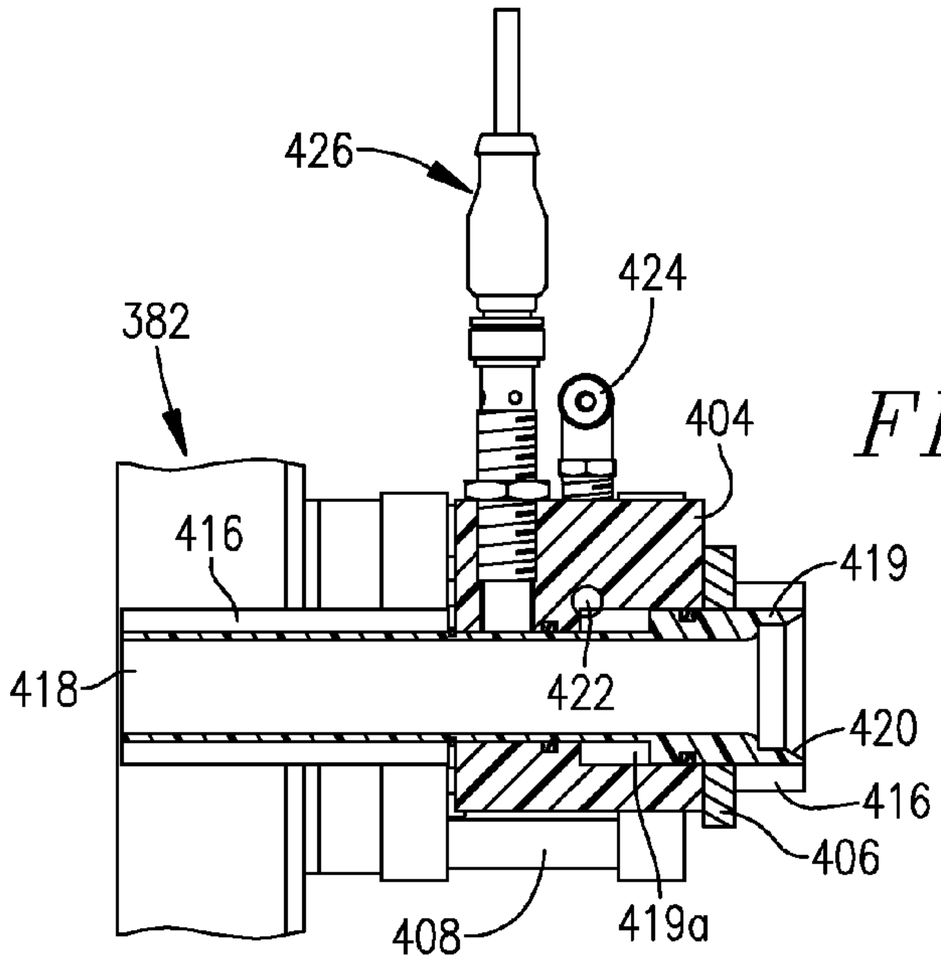
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FIG. 43.

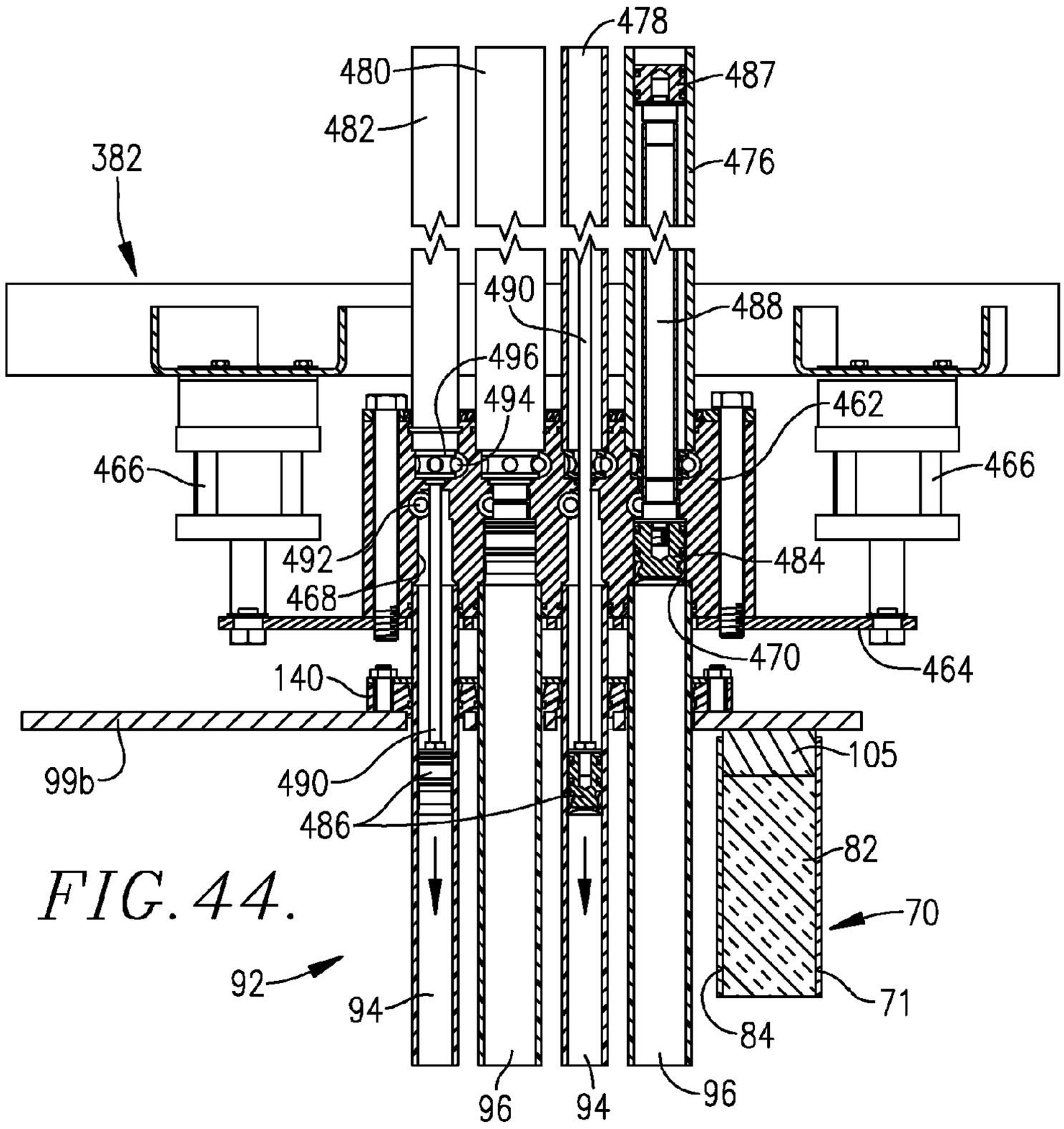

FIG. 44.

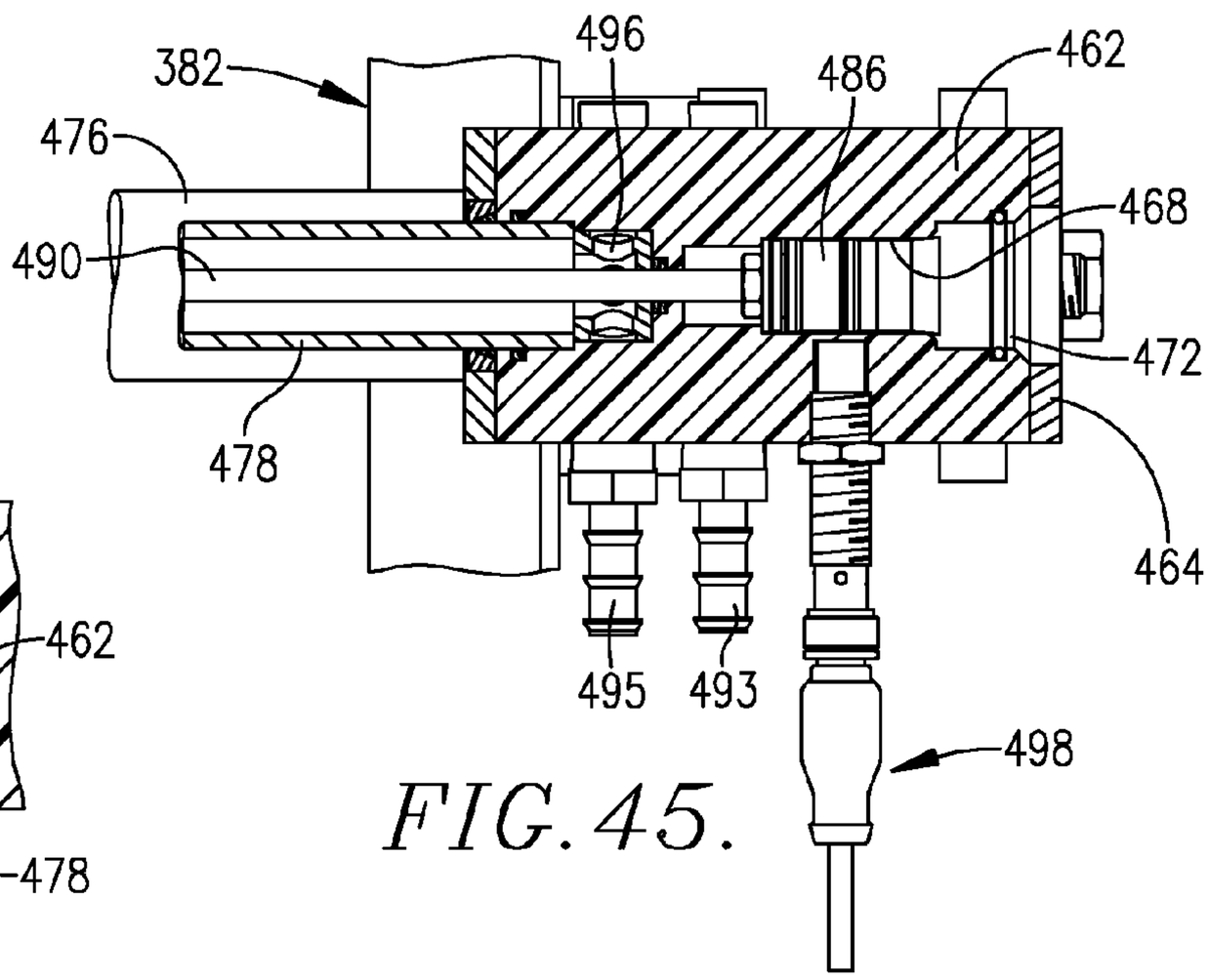

FIG. 45.

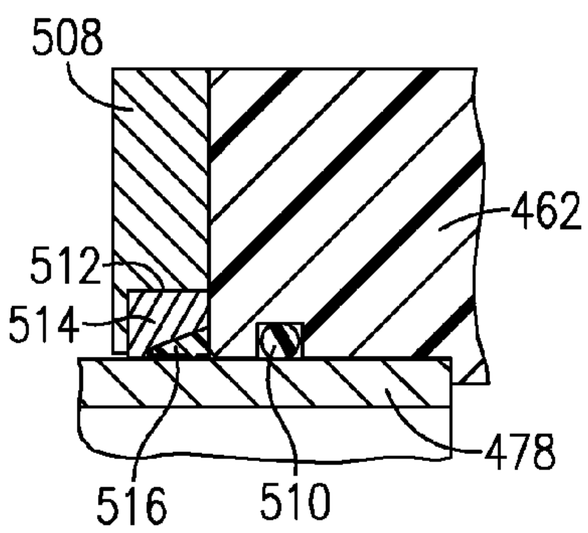

FIG. 46.

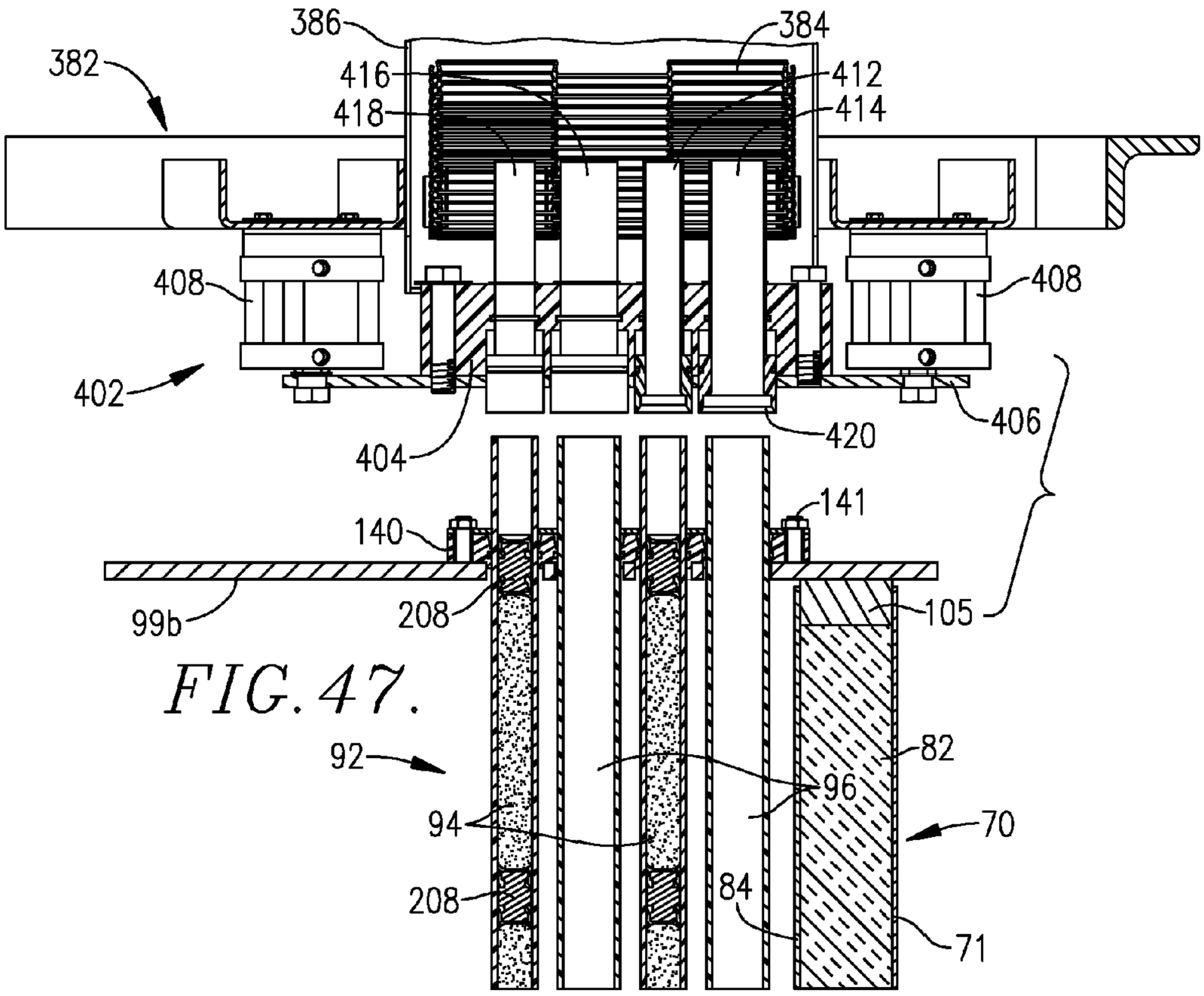
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FIG. 47.

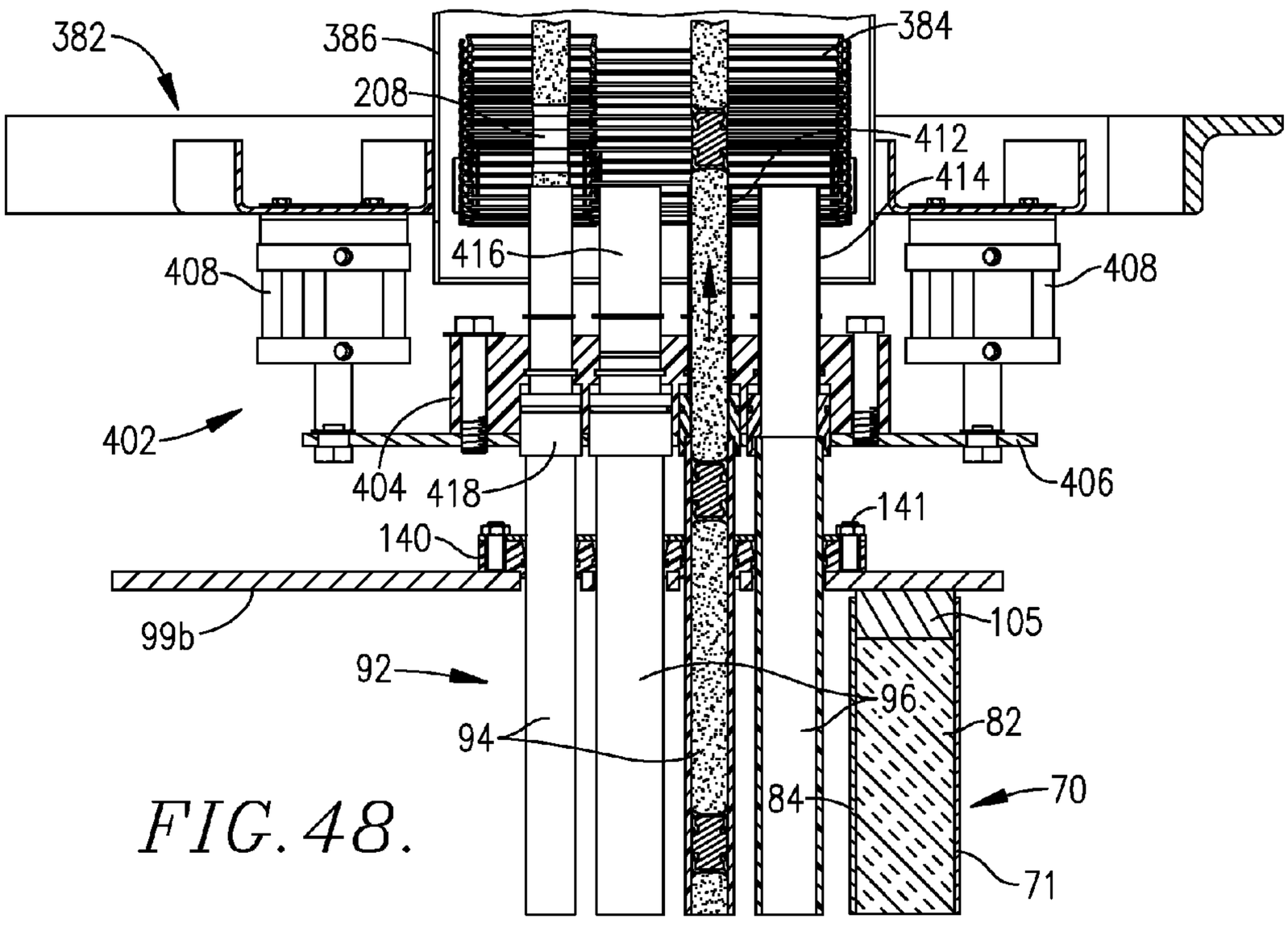
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FIG. 48.

METHOD AND APPARATUS FOR PRODUCTION OF ELONGATED MEAT PRODUCTS WITHOUT CASINGS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of application Ser. No. 12/703,396, filed Feb. 10, 2010, and further claims the benefit of Provisional Application Ser. No. 61/222,765, filed Jul. 2, 2009, and of Provisional Application Ser. No. 61/152,576, filed Feb. 13, 2009. All of the above-identified applications are incorporated by reference herein in their entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is concerned with improved apparatus and methods for the commercial-scale production of elongated cooked food items such as hot dogs, corn dogs and sausages (e.g., Vienna sausages) without the use of casings. More particularly, the invention is directed to such devices and methods wherein automated injector heads coupled with a supply of meat emulsion create successive, predetermined weight portions or charges of emulsion which are then partially or completely cooked in elongated heat exchange cooking tubes. The equipment is preferably designed so that the products are statically heated using a plurality of tubes so as to achieve a batch-continuous operation. Advantageously, the equipment provides a plurality of cooking tube arrays, and delivers meat emulsion to at least one tube array while also removing cooked product from a second array and applying oil to a third array.

2. Description of the Prior Art

Presently, elongated cooked meat products such as hotdogs, the inner meat portions of corn dogs, and Vienna sausages are produced using casings. Generally speaking, a starting meat emulsion is pumped into a casing, and the casing is twisted in order to initially form the product, followed by cooking and/or smoking to fully cook and gelatinize the protein in the emulsion. The product is chilled and the casing is stripped from the cooked product and is discarded. Such use of casing represents a very significant cost to the food processors. Indeed, many large scale plants purchase several million dollars worth of casings per year.

Attempts have been made in the past to process these meat products without the use of casings. However, these efforts have not met with any significant commercial acceptance. The principal difficulty with these prior devices has been that the products are not equivalent to the typical products made with casings. For example, the products may not have the same shape, color, or texture as the conventional counterparts, and are thus unacceptable to consumers.

U.S. Pat. No. 4,113,890 to Long describes a continuous stuffing machine **30** that feeds a tube **32** which injects emulsion into a coil **10** that is covered by a jacket **12**. A heat transfer medium, such as steam or hot water, flows through the jacket in a direction opposite to the flow of the emulsion through the coil **10**. Metal-core plugs **36** are also inserted into the coil **10** automatically by a loader **62**. The loader **62** has two similar chambers **72**, **74** that rotate about a central axis **70** that is connected to a gear **64**, which may be driven by an external motor. One chamber **74** accepts (by the use of a hydraulic ram **78**) a plug **36** from a supply line **60**, while at nearly the same time, the other chamber **72** injects (by the use of a hydraulic ram **76**) a plug **36** into a feed line **10***c*. The chambers **72**, **74** rotate and perform reciprocal tasks in repeated fashion. The plugs **36** and the partially-cooked hot dogs exit the coil **10** onto conveyor **52**, where the plugs **36** are separated by a magnetic roller **54** from the hot dogs which continue on conveyor **56**. The plugs **36** are dropped into a receptacle **58**.

U.S. Pat. No. 3,502,018 discloses a system for fully cooking sausages without casings. The system includes a stuffer **14** that forces meat emulsion into a tube which extends through multiple stages **10**, **11**, **12** of heating. Cooked sausage exits the tube **16** and is carried on a belt **26** through a cooling chamber **13**. Cooled sausage exits the cooling chamber **13** and may be cut by blade **32** before being transported by conveyor **36**.

U.S. Pat. No. 3,889,013 discloses a system for preparing frankfurters or sausages by creating a casing from the meat product itself. The system includes a supply tank **2** that supplies the meat product to a metering pump **6** which delivers pressurized meat product to a heating unit **8**. The meat product is heated in a cylindrical mold **20** to cook the outer surface of the meat product so that it forms a casing. The meat product is then cooled by the cooling unit **10**.

See also U.S. Pat. Nos. 2,182,211; 3,421,434; 4,726,093; 4,989,505; 5,056,425; 5,118,519; 6,203,832; 6,322,832; and 6,326,039.

Notwithstanding these efforts, no commercially successful has heretofore been devised which is capable of properly cooking sausage-type products without casings and while retaining the appearance, taste, and mouth feel of traditional products.

There is accordingly a real and unsatisfied need in the art for improved methods and apparatus capable of producing elongated, partially or fully cooked meat products such as hotdogs or sausages without the use of casings, while still providing finished products equivalent in all respects to conventional products of these types made using casings.

SUMMARY OF THE INVENTION

The present invention overcomes the problems outlined above and provides greatly improved methods and apparatus for the production of elongated comestible products, and especially sausage-type products such as hot dogs, without the need for disposable casings. Thus, the invention entirely eliminates the costly expedient of using disposable casings, which greatly minimizes production costs. Moreover, the invention is characterized by reduced energy consumption owing to the use of conduction cooking, reduced labor costs, and improved food safety. The system of the invention also discharges product in an organized fashion wherein the products are oriented end-to-end in straight lines, which facilitates downstream product management.

Generally speaking, the apparatus of the invention includes a plurality of elongated, separate, individual cooking tubes, each presenting a longitudinal axis and an inlet end. A loading station is provided which includes structure operable to load comestible material (e.g., meat emulsion) into the inlets of the tubes. Shifting mechanism is also provided which is operable to shift the tubes in a first direction transverse to the longitudinal axes thereof and into the loading station for successive loading. The shifting movement may be of any suitable type, such as circular or reciprocal. The overall apparatus further has a cooking arrangement to at least partially cook the comestible material within the tubes, as well as a discharge station separate from the loading station and including discharge structure for discharge of the at least partially cooked material from the cooking tubes. To this end, the shifting mechanism is also operable to successively shift the tubes

containing the at least partially cooked comestible material in a second direction also transverse to the longitudinal axes and into the discharge station.

Preferably, the cooking tubes have open inlet and outlet ends and are arranged in a circular pattern with the tubes substantially parallel with each other and in circumferentially spaced apart relationship. In this embodiment, the tubes are incrementally moved in the same direction (i.e., either clockwise or counterclockwise) into and out of the loading and discharge stations during rotation of the tube pattern. Advantageously, and in order to increase production capacity, an array of radially spaced apart tubes are provided at each circumferentially spaced apart tube position, and the loading and discharge stations are appropriately equipped to simultaneously load and discharge plural tubes. The arrays may have tubes of different diameters, so that differentially sized products may be produced on the same machine. In such an arrangement, the tubes are located within a cylindrical, axially rotatable, water-tight housing, and energy exchange media (e.g., heated water and/or steam) surrounds the tubes for cooking of the comestible material within the tubes during tube rotation.

In order to create properly formed hot dog and related products, the loading station includes structure for successively introducing forming plugs into the tubes between successive portions of the comestible material. Thus, at the loading station, each cooking tube is filled with individual portions of material with a plug on either end of and in engagement with the portion. In such operations, the discharge station is equipped with specialized apparatus for recovery of the plugs as they are discharged, in order to return the plugs to the loading station for reuse. A particularly useful feature is that the plug recovery apparatus maintains the plugs in a substantially parallel alignment with the longitudinal axes of the tubes throughout the recovery sequence. Thus, the tubes are handled in the most efficient manner and without the need for manual manipulation thereof.

The loading station of the system of the invention preferably includes an improved apparatus for loading of the cooking tubes with both portions of comestible material and forming plugs. This apparatus broadly includes a magazine operable to hold a plurality of the elongated plugs and to individually deliver the plugs to a plug delivery location. An elongated, axially shiftable plug seating rod is adjacent the magazine and is oriented to engage and move successive plugs from the plug delivery location. An elongated, axially rotatable plug and meat injection rod is provided, which is spaced from the seating rod and is located proximal to the tube inlet end, with the longitudinal axis of the injection rod being substantially coaxial with the tube longitudinal axis. The apparatus also has a portioning assembly spaced from both of the rods and includes structure for successively forming and delivering individual portions of the comestible material, as well as an input for the comestible material.

A shiftable plate is located between the injection rod and the cooking tube open end and has a plug seating and injection bore, a material conveying bore, and a material delivery bore. Shifting mechanism is coupled with the plate for selective shifting thereof between a first position wherein the seating and injection bore is aligned with the seating rod, and the material delivery bore communicates the portioning assembly with the tube inlet, and a second position wherein the seating and injection bore is aligned with the injection rod and the tube inlet, and the material conveying bore communicates the input and the portioning assembly. An operating mechanism is coupled with the plate shifting mechanism, the seating rod, the injecting rod, and the portioning assembly. This serves to shift the plate to the first position thereof and to cause (a) shifting of the seating rod to shift a plug from the plug delivery location and into the seating and injection bore of the plate, and (b) to operate the portioning assembly in order to deliver a portion of the material to the tube inlet. The operating mechanism also subsequently shifts the plate to the second position thereof and causes (c) shifting of the injection rod to shift the seated plug from the seating and injection bore and into the tube through the tube inlet, and (d) to operate the portioning assembly to create a portion of the material for subsequent delivery to the cooking tube behind the injected plug.

The preferred systems of the invention are provided with an output conveyor for finished product also having a spray assembly for the application of liquids to the cooked products, in order to increase the palatability thereof, and to facilitate downstream additional processing or packaging. A plug recovery assembly is also provided in order to recover plugs from the output conveyor and to direct these plugs for reuse; if desired, the plugs may be washed during recovery thereof.

An additional feature of the invention is the provision of a plug storage assembly, which is an adjunct of the plug recovery assembly. The storage assembly is operable to create accumulated rows of plugs from the discharge station and to successively move such rows onto a receiving rack.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a processing system in accordance with the present invention, operable for the batch-continuous production of elongated, sausage-type products, and viewing the input end of the system;

FIG. **2** is another perspective view of the processing system of FIG. **1**, but viewing the output end thereof;

FIG. **3** is an end elevational view of the processing system, viewing the input end thereof;

FIG. **4** is an end elevational view of the front face of a gate assembly forming a part of the input end of the processing system, and supporting the plug and meat emulsion injection assembly;

FIG. **5** is a perspective view of the plug and meat emulsion injection assembly of FIG. **4**, viewing the rear face thereof;

FIG. **6** is a fragmentary, perspective view of the plug and meat emulsion injection assembly of FIGS. **4** and **5**, viewing downwardly from the top thereof;

FIG. **7** is a fragmentary, vertical sectional view of the plug and meat emulsion injection assembly of FIGS. **4-6**;

FIG. **8** is an exploded, perspective view of the plug and meat emulsion injection assembly;

FIG. **9** is a fragmentary, vertical sectional view of a portion of the plug and meat emulsion injection assembly, and illustrating delivery of plugs to a plug magazine;

FIG. **10** is a fragmentary, exploded, perspective view depicting one of the magnetic plug pickups forming a part of the plug and meat emulsion injection assembly;

FIG. **11** is a perspective sectional view of one of the magnetic pickups;

FIG. **12** is an end elevational view of the input end of the processing system, with the gate assembly removed and illustrating the input end of the cooking drum;

FIG. **13** is a vertical sectional view of the cooking drum of the system, taken at a central location;

FIG. **14** is another vertical sectional view of the cooking drum, at a location closer to the inlet end of the drum, as compared with FIG. **13**;

FIG. **15** is an fragmentary, sectional view illustrating the operation of the cooking drum indexing device operable to incrementally rotate the drum during operation of the processing system;

FIG. **16** is a perspective view of internal components of the cooking drum;

FIG. **17** is an enlarged, fragmentary, sectional view illustrating the steam injection assembly forming a part of the cooking drum;

FIG. **18** is a plan view of the plug storage racks of the processing system;

FIG. **19** is a perspective view of one of the storage racks, and illustrating plug-holding supports for both small and large plugs;

FIG. **20** is a perspective view of a plug storage rack, viewing the underside thereof;

FIG. **21** is an end elevational view of a plug storage rack;

FIG. **22** is a fragmentary perspective view illustrating the progression of plugs through the plug storage assembly and into the plug and meat emulsion injection assembly;

FIG. **23** is a fragmentary perspective view similar to that of FIG. **22**, but illustrating the initial operation of plug storage;

FIG. **24** is a fragmentary, vertical sectional view illustrating the second step of plug storage, wherein a row of plugs is elevated and delivered to the plug conveyor;

FIG. **25** is a fragmentary, vertical sectional view similar to FIG. **24**, illustrating the completion of plug storage with the storage rack lowered;

FIG. **26** is a perspective view of the output assembly forming a part of the processing system;

FIG. **27** is an end view of the output assembly;

FIG. **28** is a vertical sectional view depicting the configuration of the plug and meat emulsion injection assembly in the standby position thereof while the cooking drum is indexed;

FIG. **29** is a sectional view similar to that of FIG. **28**, depicting the configuration of the plug and meat emulsion injection assembly during an initial plug injection sequence;

FIG. **30** is a sectional view similar to that of FIG. **29**, depicting the configuration of the plug and meat emulsion injection assembly during drawing of a charge of meat emulsion and injection of a plug into a cooking tube;

FIG. **31** is a sectional view similar to that of FIG. **30**, depicting the configuration of the plug and meat emulsion injection assembly during injection of a charge of meat emulsion into the cooking tube behind the previously injected plug;

FIG. **31**A is a fragmentary sectional view illustrating an alternative embodiment wherein a source of pressurized air is directed against the leading forming plugs within the cooking tubes during loading of the tubes with plugs and meat emulsion portions, and/or during cooking of the meat emulsion;

FIG. **32** is a sectional view similar to that of FIG. **31**, depicting the configuration of the plug and meat emulsion injection assembly during injection of a second plug behind the previously injected emulsion charge and within the delivery tube;

FIG. **33** is a sectional view similar to that of FIG. **32**, depicting the configuration of the plug and meat emulsion injection assembly during insertion of the second plug into the cooking tube behind the previously injected emulsion charge;

FIG. **34** is a sectional view of the meat emulsion delivery block and illustrating the connection thereof to a pair of emulsion cylinders forming a part of the plug and meat emulsion injection assembly;

FIG. **35** is a fragmentary sectional view illustrating a pair of delivery tubes forming a part of the plug and meat emulsion injection assembly, with the delivery tubes mated with corresponding cooking tubes of the cooking drum;

FIG. **36** is a view similar to that of FIG. **35**, but illustrating the alternate use of larger diameter cooking tubes for the production of differently sized end products, as compared with FIG. **35**;

FIG. **37** is an enlarged, vertical sectional view illustrating a plug injected into one of the delivery tubes;

FIG. **38** is a greatly enlarged, fragmentary sectional view depicting the plug-retaining shoulder of the delivery tube;

FIG. **39** is an enlarged sectional view of the input end of a cooking tube;

FIG. **40** is a fragmentary, enlarged sectional view illustrating the plug-retaining should of the input end of the cooking tube;

FIG. **41** is a fragmentary sectional view illustrating the operation of the water eject assembly forming a part of the processing system;

FIG. **42** is a fragmentary, sectional view illustrating the components of the oil application assembly forming a part of the processing system, with the oil injection system in its standby mode;

FIG. **43** is a fragmentary, vertical sectional view illustrating an air cushion assembly at the outlet end of a cooking tube;

FIG. **44** is a view similar to that of FIG. **42**, but showing the oil application assembly in operation during injection of oil into the cooking tubes;

FIG. **45** is a fragmentary, vertical, sectional view illustrating components of the oil application assembly;

FIG. **46** is a fragmentary sectional view illustrating the end seal arrangement in the oil application assembly;

FIG. **47** is a sectional view illustrating the output end of the cooking tubes and the product and plug delivery assembly, with the latter in a standby mode during indexing of the cooking drum;

FIG. **48** is a view similar to that of FIG. **47**, but illustrating the product and plug delivery assembly engaged with the output ends of the cooking tube, during delivery of cooked products and plugs; and

FIG. **49** is a fragmentary, sectional view illustrating an alternate, spring-biased cooking tube embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Turning now to the drawings, a processing system **50** is illustrated in FIGS. **1** and **2**. The system **50** presents an input end **52** and an output end **54**, and broadly includes a cooking drum assembly **56**, a gate assembly **58** at the input end **52** supporting a control panel **60**, a forming plug and meat emulsion injection assembly **62**, and a water ejection assembly **63**. A cooked product output conveyor **64** is situated adjacent output end **54**, along with a finished product and plug delivery assembly **65**, a plug recovery assembly **66**, and an oil application assembly **68**. A plug storage assembly **69** is situated above cooking drum assembly **56**, as shown. The system **50** is designed to produce elongated, cooked, commercially acceptable sausage-type products on a continuous basis without the use of casings. In the system **50**, the assembly **62** defines a loading station, whereas assemblies **63** and **65** and conveyor **64** cooperatively define a discharge station.

Cooking Drum Assembly **56**

In more detail, the cooking drum assembly **56** includes an elongated, axially rotatable, cylindrical housing **70** supported on a frame assembly **72**. The latter has upright corner posts **74**

with interconnecting lateral frame members **76**, **78** and a pair of upright central posts **80** at each end of the frame assembly. The housing **70** comprises an outer wall **71**, an inner wall **84**, with end spacers **105** (see FIGS. **41-42**) and intermediate spacers **85** interconnecting the walls **71**, **84**. Thermal insulation **82** is situated between the walls **71**, **84** (see FIG. **41**). A series of temperature probes **86** are mounted on housing **70** and extend into the interior of the housing **70**, along with a steam vent **91**. The vent **91** can be opened in order to allow filling of the housing **70** with water.

Internally, the assembly **56** has a plurality of radially extending, circumferentially spaced apart tube arrays **92**. Each such array is made up of two smaller diameter cooking tubes **94** and two larger diameter cooking tubes **96**. Each tube has an inlet end presenting an inwardly extending, plug-retaining shoulder **97** (see FIGS. **39-40**). All of the tubes **94**, **96** are substantially rectilinear and extend the full length of housing **56**, and are supported by fore and aft annular, apertured plates **98**, **100**. In addition, two intermediate supporting plates (not shown), identical to the plates **98**, **100**, are located between the latter. The plates **98**, **100** and the intermediate plates are in maintained in proper spaced relationship by elongated rigid rods **102**. An elongated, tubular, fixed, central mounting member **104** having fore and aft bearing surfaces **106**, **108** also extends the full length of the housing **70**. The outboard ends of the mounting member **104** are supported by fittings **110** affixed to the central posts **80** (see FIG. **12**).

A stationary steam injection assembly **112** is positioned within housing **70** and includes a steam injection pipe **114** extending through the forward portion of mounting member **104** and terminating in an injection manifold **116** (FIG. **17**). The manifold **116** supports a total of four radially extending, circumferentially spaced steam delivery stems **118** in communication with pipe **114**; each stem **118** has a check valve **119** therein to prevent backward flow of water into the steam injection assembly **112**. The stems **118** are operably coupled with a total of four elongated, axially extending steam tubes **120** within housing **70** and having apertures for delivery of steam throughout the entire lengths thereof. The ends of the tubes **120** are supported on circular mounts **122**, which are in turn secured to mounting member **104**.

The ends of the housing **70** are defined by solid, apertured fore and aft bulkheads **99***a* and **99***b*, which have the identical pattern of apertures of the corresponding plates **98**, **100** (see FIGS. **2** and **12-14**). The bulkheads also have a solid section **124** inboard of the arrays **92**, equipped with central nylon bearings engaging the bearing surfaces **106**, **108**. The bulkheads **99***a*, **99***b* are secured to housing **70** by means of threaded fasteners extending through the bulkhead margins and coupled with internal spacer rings **105**.

Referring to FIGS. **12-14**, the input bulkhead **99***a* is provided with an integral, annular indexing ring section **126** having a series of outermost teeth **128**. An indexing drive **130** is mounted to the forward portion of frame assembly **72**, and has a pivotally mounted pneumatic actuating cylinder **132** with an extendable rod **134** terminating in a fixture **136** complemental with teeth **128** (FIGS. **14-15**). A pivotal locking element **137** serves to hold the housing **70** in place between indexing movements thereof. A total of three dual roller guides **138** are secured to the forward corner posts **74** and engage indexing ring section **126** in order to assure smooth rotation of the cooking drum. It will be appreciated that the ring **126** and drive **130** provide a mechanism for incremental shifting of the housing **70** and thus tubes **94**, **96**.

Referring now to exemplary cooking FIG. **35**, an array **92** of cooking tubes **94**, **96** is illustrated, along with the associated sealing structure. Specifically, at the forward end of the array **92**, an apertured sealing block **140** is provided secured by fasteners **141** to bulkhead **99***a*. The sealing block **140** is equipped with sealing rings to provide a watertight seal. The aft end of the tube array **92** is likewise provided with an identical sealing block **140** (see FIG. **41**) in order to provide the same type of seal. In practice, each of the sealing blocks **140** is used to seal a pair of adjacent tube arrays **92**.

Referring to FIG. **49**, an alternate embodiment is illustrated. In this case, the cooking tubes, such as exemplary cooking tube **96***a*, are shiftable during operation of the processing system. Accordingly, the cooking tubes are sealed by means of a sealing block **140***a* secured to bulkhead **99***b* by fasteners **141***a*. In addition, it will be observed that a biasing spring **144** is positioned about the aft end of tube **96***a* and abuts the rear sealing block **140***a*, which biases the outer ends of the tube away from bulkhead **99***a*. The spring **144** is within a housing **146**, which is secured between a connecting ring **148** and the fasteners **141**. The rearmost end of tube **140** has a bevel **150**, as shown. A tubular, beveled actuator **150***a* is designed to mate with bevel **150** during operation of the alternate embodiment, as will be described. As also depicted in FIG. **49**, the bulkheads **99***a*, **99***b* are secured to housing **70** by means of annular endmost connector rings **152** secured to the inner surface of the housing and which receive threaded fasteners (not shown).

Gate Assembly **58**

Referring to FIGS. **5-7**, the gate assembly **58** supports control panel **60** as well as the plug and meat emulsion injection assembly **62**. The gate assembly includes a rigid box frame **154** having uprights **158** with upper and lower crosspieces **160**, **162**. In addition, the gate assembly **58** has an adjustment mechanism **164** having a pair of stationary, inclined frame tubes **166**, **168** each having a pair of spaced-apart clamping screws **170**, **172** (FIG. **5**). The upright **158** is equipped with a pair of latching elements **174** which mate with latches **175**, attached to the right-hand corner post **74**, as viewed in FIG. **3**. An elongated pivot rod **176** extends between and is secured to the upper and lower crosspieces **160**, **162** with the outermost ends of the rod **176** secured to the left-hand corner post **74** by couplers **177**, as viewed in FIG. **3**. In this fashion, the entire gate assembly **58** can be moved between a closed, operating position adjacent the input end of the cooking drum, or to an open position allowing access to the cooking drum.

The control panel **60** is secured between the upper and lower crosspieces **160**, **162** by means of standoff connectors **178**. The control panel **60** is itself conventional, and includes the usual digital control components for system **50**. It also receives inputs from the sensors described below.

Forming Plug and Meat Emulsion Injection Assembly **62**—Plug Handling Subassembly **180**

Referring to FIGS. **5-6**, the plug and meat emulsion injection assembly **62** broadly includes a plug handling subassembly **180** and a plug and meat emulsion injection subassembly **182**. The subassembly **180** has a pair of identical, right- and left-hand plug elevators **184** leading to a common, generally V-shaped plug magazine **186**. Each of the elevators **184** is connected to upper crosspiece **160** by connection blocks **185** and has a continuous roller chain **188** trained about upper and lower sprockets **190** and powered by motor **192**. FIGS. **9-11** depict chain guard structure **189** is provided about the roller chain **188**, as shown. Each link of the roller chain **188** supports a laterally extending lug **194**. Every other lug carries a magnetic plug pickup **196** with intervening lugs supporting blanks **198**. Referring to FIGS. **10** and **11**, it will be seen that each pickup **196** includes a mounting plate **200**, a circular

magnet **202**, and a plug cradle **204**, these components secured together via screws **206**. Each of the pickups **196** is operable to engage and hold a plug **208** delivered to the corresponding elevator by the plug recovery subassembly described below. The delivered plugs **208** are carried downwardly by the moving chain **188** and the pickups **196** to the magazine **186**. The magazine **186** has a pair of upright, obliquely oriented channels **210**, **212**, extending upwardly from a common base **213**; each of the channels **210**, **212** has an inlet throat **214** and a lower, elongated, tubular plug outlet passageway structure **215** separate from base **213** and attached thereto; the passageway structure **215** is in registry with an opening **215***a*. Each throat **214** presents a plug detachment segment **216**.

In order to provide enhanced automated control, the channels **210**, **212** are each provided with upper and lower proximity sensors **210***a*, **210***b*. These sensors are operable to sense the presence of plugs **208** within the respective channels, and to monitor the plug output through the lower outlet passageway structures **215**.

Forming Plugs **208**

The preferred forming plugs **208** are illustrated in FIGS. **37** and **38**. Each plug **208** has a central metallic body **218** presenting an outermost cylindrical surface **220**. The body **218** is formed of an appropriate metal for magnetic handling of the plugs. In addition, the plugs **208** have endmost resilient synthetic resin caps **222**, which are fastened to body **218** and have concave outboard surfaces **224**. If desired, the surfaces **224** may be configured with elongated projections, so that the final formed product may exhibit the appearance of casing wrinkles found in conventionally-produced hot dog products, for example. Additionally, each of the caps **222** have an outer periphery **226**, which is slightly greater than the diameter of the corresponding cooking tubes. It will be appreciated that differently sized plugs are provided for use with the smaller and larger diameter cooking tubes **94** and **96**. The illustrated plugs **208** are for use with the smaller diameter cooking tubes **94**.

Plug and Meat Emulsion Injection Subassembly **182**

FIG. **8** illustrates the assembly **182**, including an upright injector support plate **228**, which is secured to a slide frame **230**, the latter being attached to the gate assembly frame tubes **166**, **168**. The slide frame **230** includes slotted upper and lower frame members **232** and **234**, as well as spaced apart uprights **236**, **238** (see FIG. **5**). The screws **170**, **172** forming a part of the gate assembly secure the slide frame **230**, and thus plate **228**, in alternate positions. A total of four apertured support blocks **240** are attached to the uprights **236**, **238**.

The plate **228** is shiftable fore and aft by means of four pancake cylinders **244**, each having and extendable rod **246**. The position of the pancake cylinders **244** is monitored by way of proximity sensors **245** (FIG. **6**). Each rod **246** extends through a corresponding support block **240** and is secured to plate **228** by bolts **248**. The upper and lower pairs of pancake cylinders **244** are interconnected by means of respective support channels **250**, **252**. The channels **250**, **252** each have an elongated support legs **254**, which are affixed to the slide frame **230** and uprights **236**, **238**. A total of four rigid mounting rods **256** are also secured to the plate **228** and extend therefrom. The outermost end of each rod **256** is provided with a clamping sleeve **258** and a threaded, rotatable clamping knob **260**.

The plate **228** has two lower meat emulsion delivery openings **262** therethough, as well as a pair of plug and meat injection openings **264**. The openings **264** are designed to receive tubular delivery elements **265**, each having a beveled outlet end **265***a* equipped with a sealing ring **265***b* (see FIG. **37**). The inlet end of each element **265** has an annular, inwardly extending, plug-retaining shoulder **265***c* (FIGS. **37-38**). The elements **265** are changed when different diameter products are being produced, as explained below. The plate **228** further has a pair of spaced apart keyhole openings **266** designed to receive respective vacuum fittings **268**.

The rods **256** support a pair of upright plates **270**, **272**. Plate **270** includes a pair of vertical, apertured spacers **274**, and also has a series of openings through the plate between the spacers **274**. In particular, the plate **270** has a pair of plug and meat emulsion injection openings **276**, a lower pair of meat emulsion delivery openings **278**, each equipped with a stationary, tubular, projecting fitting **279**, and a pair of vacuum openings **280**, which receive the fittings **268**. It will be observed (FIG. **28**) that the vacuum openings **280** communicate with the opposite face of the plate **270**.

The plate **272** has a pair of upper plug-receiving openings **286** equipped with entry ferrules **288**, and a pair of lower meat emulsion conveying openings **290** with tubular beveled inserts **292** therein. The plate **272** also has a pair of injector rod openings **294** between the openings **286** and **290**, and a pair of vacuum openings **296** equipped with vacuum fittings **298**. The vacuum openings **296** communicate with the opposite face of plate **272**. The face of plate **272** remote from plate **270** is provided with attachment screws **304**, **306** to permit attachment of actuating cylinder structure, as described below.

FIG. **8** also illustrates a vertically shiftable injection head assembly **308** is located between the plates **270** and **272**, and broadly includes an apertured and internally slotted plate **310** and a pneumatic actuating cylinder **312**. The cylinder **312** is secured to the upper ends of the plates **270**, **272**, and has a downwardly extending rod **314** threaded into the upper end of plate **310**. The plate **310** has a pair of lower meat emulsion conveying openings **316** and a corresponding pair of vertically offset, upper meat emulsion conveying openings **318**, with each pair of openings **316**, **318** connected via an internal oblique passageway **320**. Additionally, the plate **310** has a pair of through openings **322** above the openings **316**, and a pair of plug injection openings **324** with internal tubular inserts **326** therein.

FIG. **28** illustrates a number of pneumatic actuating cylinders secured to plate **272**, including a pair of meat emulsion portioning cylinders **328** aligned with the openings **290** and secured in place by the fittings **304**, and a pair of plug injection cylinders **330** aligned with the openings **294** and secured by the fittings **306**. Each cylinder **328** includes a shiftable rod **332** supporting a plunger head **334** equipped with sealing structure **336**. A surrounding housing **338** extends between the base of the cylinder **328** and fitting **304** and defines a fluidtight portioning chamber **340**. As shown, the plunger **334** sealingly engages the housing **338** and also, in the extended position thereof, sealingly engages the associated beveled insert **292**. The stroke of rod **332** is adjustable by means of stroke length control mechanism **342**. Each cylinder **330** has a shiftable rod **344** terminating in a rounded end **346** which, in the retracted position thereof, is seated within the associated fitting **306** and the opening **294**.

A pair of plug injection seating rods **348** are located in registry with the openings **215***a* and are supported by a crosspiece **350**. A small pneumatic actuating cylinder **352** having extensible rod **354** is secured to crosspiece **350** in order to simultaneously move the rods **348**. Cylinder **352** is supported on an elongated bracket **356** secured to plate **272**.

As best viewed in FIG. **6**, the V-shaped magazine **186** is mounted on the bracket **356** and also rests upon the upper set of rods **256**. Moreover, in the operating condition of assembly

182, the clamping sleeves 258 and knobs 260 serve to hold the components of the assembly together, i.e., the sleeves 258 bear against the adjacent face of plate 272.

The assembly 282 also has a meat emulsion delivery unit 358 operable to deliver meat emulsion from a pressurized source to the system 50. Preferably, the meat emulsion is generated by a Marlen twin piston pump, although any suitable food pump may be used. The unit 358 includes a primary emulsion conduit 360 with an upstanding delivery pipe 362 (FIG. 12). An elbow conduit 364 is secured to pipe 362 and in turn is coupled with a meat delivery block 366. The block 366 is affixed to the face of plate 228 adjacent the cooking drum, and has a pair of outlet openings 368 connected by passageway 370 and communicating with conduit 364. The outlet openings 368 mate with the fittings 279 to provide a liquidtight seal (FIGS. 28 and 34).

Water Ejection Assembly 63

The ejection assembly 63 includes a water block 372 having a pair of water inlets 374 and a corresponding pair of tubular water outlets 376. Each outlet 376 is equipped with an o-ring seal 378 (FIGS. 5, 8, and 41). The block 372 is secured to plate 228 by means of attachment pin 380 and a vertical locating pin 381 (see FIG. 41) allowing replacement of the block when different sized products are being produced. The assembly 63 serves to remove cooked products and forming plugs 208 from the cooking tubes by injection of hot water or oil, as will be explained below.

Output Conveyor 64

Referring to FIGS. 2, 26, and 27, the output conveyor 64 includes a frame 382 and an elongated, endless, draining wire conveyor belt 384. The frame 382 is designed to be bolted to the output end of frame 72. The belt 384 is powered by means of motor 388 and is operable to deliver cooked product to the outlet end 390 thereof. One or more intermediate spray heads (not shown) are positioned above belt 384 and beneath a spray housing 392. The spray head(s) are operably coupled with a pump 394 in order to deliver liquid (e.g., vinegar) to the heads from a storage tank 398. In addition, an oil pump 396 is provided, along with an oil tank 400, in order to supply vegetable oil to the assembly 68.

A trough 432 extends the full length of conveyor 64 below the lower run of belt 384 and has three section sections: a first water collection section adjacent the forward end of the frame 382; a second vinegar collection section separated from the first section by a baffle plate; and third section separated from the second section by another baffle plate and terminating at an open end adjacent output end 390 of the conveyor. The first water collection section of the trough 432 has an oblique discharge outlet 434. The outlet 434 is typically equipped with a discharge hose or similar device for water disposal purposes. The second vinegar collection section also has an outlet similar to the outlet 434.

Finished Product and Plug Delivery Assembly 65

FIG. 27 illustrates the finished product and plug delivery assembly 65 comprising mechanism 402 mounted on frame 382 and operable to successfully deliver cooked products and plugs onto belt 384. The mechanism 402 includes a block 404 secured to a shiftable plate 406. The plate is in turn supported by a pair of pancake cylinders 408 affixed to frame 382. The block carries an array 410 of four tubular outlets 412-418 sized and designed to mate with an array 92 of cooking tubes. The input ends 419 of the outlets 412-418 are situated within an enlarged opening 419*a* and present a beveled surface 420 (see FIGS. 43 and 47), whereas the outlet ends thereof closely overlie the upper run of belt 384. A common bore 422 is provided for the outlets 412-418, located to communicate with the corresponding enlarged opening 419*a*. An air inlet fitting 424 is secured to block 404 and communicates with the bore 422, so as to maintain a slight positive pressure within the openings 419*a*. This gives a slight cushioning effect when the input ends 419 mate with the corresponding cooking tubes 94, 96.

The block 404 and tubes 412-418 are shiftable between a standby position (FIG. 47) and an operating position (FIG. 48). A series or proximity sensors 426 are secured to block 404 in order to count the plugs 208 from the tube array. In addition, a proximity sensor 430 is provided so as to monitor the position of the pancake cylinders 408.

Plug Recovery Assembly 66

The plug recovery assembly 66 includes a driven wire belt 438 having an inclined stretch and a horizontal stretch. The belt 438 is trained about a lower roller 440 and a mating upper roller (not shown). The roller 440 has a magnetic core serving to magnetically pick up the plugs 208 as they travel along the length of belt 438 after exiting mechanism 402, and thus separates the plugs from the finished product. The plugs are then conveyed upwardly and horizontally as shown. A portion of the belt 438 passes through the housing 442 where a wash/drain assembly is provided for washing the plugs as they travel through the housing 442. This wash/drain assembly is an optional feature of the system 50.

A pair of laterally spaced apart plug conveyors 450, 452 are provided downstream of the horizontal stretch of belt 438 and receive the plugs from the latter. Each conveyor 450, 452 has a pair of vertically spaced apart forward rollers 454, a rearmost driven roller 456, and an idler roller 458. A motor 460 is provided to power each of the belts 450, 452. The upper runs 450*a*, 452*a* convey the plugs 208 toward and into the corresponding elevators 184, where they are picked up by the magnetic pickups 196 carried on the roller chains 188 (see FIG. 18).

Oil Application Assembly 68

FIG. 42 illustrates the assembly 68, which is designed to deposit a thin film of a 2:1 volumetric mixture of lecithin and vegetable oil along the inner surfaces of each of the cooking tubes 94, 96 prior to filling thereof. The assembly 68 is carried adjacent the front end of conveyor frame 382, and includes a synthetic resin block 462 secured to a cross plate 464, the latter being supported by a pair of pancake cylinders 466 attached to the frame 382. The block 462 has four laterally spaced apart bores, with two of the bores 468 in alignment with and sized for communication with the smaller diameter tubes 94 of a tube array 92; the other two bores 470 are in alignment with and sized for communication with the larger diameter tubes 96 of the array 92. The inlet ends 472 of the bores 468 are configured to mate with the output ends of the tubes 94, and similarly the inlet ends 474 of the bores 470 mate with the output ends of the larger diameter tubes 96. Four rearwardly extending oil tubes 476-482 are secured to the rear face of block 462, and communicate with the bores 468, 470. As best seen in FIGS. 42 and 44, the oil tubes 476 and 480 are of large diameter, while the tubes 478 and 482 are of smaller diameter.

An elongated rod assembly is situated within each of the tubes 476-482 and includes a forward most swab piston 484 associated with the larger diameters tubes 476 and 480 and a smaller diameter piston 486 associated with the smaller diameter tubes 478, 482. Elongated rods 488 extend rearwardly from the swab pistons 484, and likewise elongated rods 490 extend rearwardly from the swab pistons 486. Each rod has a piston 487 of appropriate diameter secured to the rearmost

end thereof. The tubes **476-482** and internal rods **488**, **490**, are of essentially the same length as the cooking tubes **94**, **96** and these components extend rearwardly below the lower run of conveyor belt **384**.

The block **462** includes four oil inlet passageways **492** coupled with nipple **493**, each located adjacent the rear face of a swab piston **484**, **486**. The block also has four other oil inlet passageways **494** coupled with nipple **495** spaced rearwardly of the corresponding inlets **492**. A stationary, apertured bushing **496** of appropriate diameter is situated within each of the bores **468**, **470** immediately in front of the rearwardly-extending tubes **476-482**.

In order to maintain automated control, four proximity sensors **498** are provided for the bores **468**, **470**, and a sensor **500** is provided to sense the condition of the pancake cylinders **466**.

As best seen in FIGS. **45** and **46**, the block **462** has an apertured rear plate **508** which receives the tubes **476-482**. In order to provide an oil-tight seal about each of the tubes, the block **462** has o-rings **510** and the rear plate **508** is notched as at **512** about each tube. An annular seat **514** is within each notch **512**, and mates with an annular, compressible seal **516**.

Plug Storage Assembly **69**

During production runs using the system **50**, the plugs **208** are continuously reused as cooked product is produced. However, at the end of a production run during cleanup, or when a different sized product is to be produced, the plugs **208** are conveniently stored for subsequent use. To this end, a plug storage assembly **69** is provided above the cooking drum assembly **56**, close to the input end thereof. In general, the assembly **69** has a pair of left- and right-hand storage units **518**. Inasmuch as the units are identical, only the lefthand unit **518** will be described in detail.

In particular, the unit **518** includes a box frame **520** presenting sidewalls **522**, **524** and an end wall **526**. A pair of transverse shafts **528** and **530** extend along the length of the unit within box frame **520**. Each of the shafts **528**, **530** has a pair of sprockets **532**, **534** thereon, which support a pair of laterally spaced roller chains **536**, **538**. A drive motor **540** is operably coupled with shaft **530** in order to move the roller chains **536**, **538**. A plurality of elongated, generally L-shaped flights **542** are attached to aligned links of the roller chains **536**, **538**, and extend the full lateral distance between sidewalls **522**, **524**. The outwardly extending segments **544** of the flights **542** are sized to engage and convey a row of plugs **208**, as later described.

The box frame **520** also is equipped with a gate mechanism **546** comprising a pair of individually shiftable gates **548**, **549**. Each gate **548**, **549** has a mounting element **550** within a corresponding slot **552** respectively adjacent the inner surfaces of the side walls **522**, **524**. The gates are individually movable by means of a small pneumatic piston and cylinder assembly **554**, **555**. In the retracted position of the gate mechanism (FIG. **22**), the gates **548**, **549** are located out of blocking relationship to the belt run **450***a* (FIG. **25**).

The unit **518** also includes a magnetic pickup roller **556**, which is situated adjacent belt run **450***a* and has a row of magnets **558** each operable to pick up a respective plug **208** of a row thereof. The roller **556** is mounted between the gates **548**, **549** as shown, and rotates by means of motor **560**. An arcuate plug retainer guide wall **562** extends from the periphery of roller **556** remote from belt run **450***a* downwardly to a rack loading location.

The unit **518** is equipped with a plug rack **564** or **566** for receipt of smaller or larger diameter plugs **208**. The selected rack is supported beneath the roller chains **536**, **538** by means of a rack elevator assembly **568**. As best seen in FIGS. **24-25**, the rack **564** presents a series of spaced apart plug-storing recesses **570** extending between the sidewalls **522**, **524**, as well as corner blocks **525** mounted to the underside thereof. The assembly **568** includes a pair of opposed, depending walls **573** and a crank mechanism **574** operable to selectively raise and lower a rack **564** or **566**. The foreground wall **573** illustrated in FIG. **20** supports an upstanding rack stop **567**. The mechanism **574** includes a lever **576** mounted on a depending wall **573** and is operated by means of pneumatic cylinder **578**. An elongated pivot rod **580** extends between the walls **573** and is coupled with lever **576**. A pair of linkages **577** are mounted on the outer face of each wall **573** and are coupled with rod **580**. Each linkage includes a coupler **582** secured to the outer end of the rod **580**, with a pair of elongated linkage rods **586** secured thereto. Each linkage rod **586** is in turn connected with a pivotally mounted crank **588** having an outermost adjustment screw **588***a* located below the respective corner blocks **525**. The underside of the unit **518** also has four corner-mounted connection walls **589**, which permit attachment of the unit **518** to frame assembly **72**. As illustrated, the cylinder **578** is secured to the inner surface of one of the walls **589**.

The unit **518** is also provided with proximity sensors **589***a* to facilitate control thereof during operation, as described below.

Operation

In the ensuing discussion, the production of hot dog products using system **50** will be described, wherein only the small diameter cooking tubes **94** are employed. Hence, the larger diameter tubes **96** are not used for any purpose. For such operation, the gate assembly is closed and latched with slide frame **230** is in the upper position thereof as depicted in FIG. **5**, and the strokes of the cylinders **328** are adjusted via mechanisms **342** to deliver the proper portions of meat emulsion. Small diameter change parts are also installed, namely the delivery elements **265**, vacuum fittings **268**, water block **372**, plug magazine **186**, entry ferrules **288**, and inserts **326** of plate **310**; and if the plug storage assembly **69** is to be used, the small plug racks **564** are installed.

In general, the operation of system **50** involves continuous cooking and plug recovery, with intermittent indexing movement of the cooking drum assembly **56**. When the drum assembly **56** is stationary after each increment of rotation, three individual operations occur substantially simultaneously, namely (1) filling of empty and previously oiled small diameter tubes **94** of an array **92***a* with injection of successive charges of meat emulsion and forming plugs **208**; (2) oiling of empty tubes **94** in an array **92***b* immediately adjacent and upstream of the array **92***a* being filled; and (3) ejection of cooked product and plugs from the tubes **94** of another array **92***c* spaced two arrays from the array **92***b*.

Cooking occurs owing to the fact that the housing **70** is filled with water, with steam injection into pipe **114**, so that the steam travels through the stems **118** and the steam tubes **120**. This serves to inject steam into the surrounding water so as to heat the latter and thus effect cooking of product within the tubes **94**. The temperature probes **86** are continuously monitored in order to maintain proper cooking temperatures within the housing **70** As indicated, this cooking step occurs continuously during operation of system **50**.

It is next assumed that the cooking drum has been indexed to a new incremental position by the operation of indexing drive **130**, while the assemblies **63**, **65** and **68**, and subassembly **182**, are in their standing positions spaced from the ends of the cooking tubes (see FIGS. **42** and **47**). This involves

operation of cylinder **132** to withdraw fixture **136** from the initial tooth, whereupon the cylinder pivots downwardly in an orientation such that fixture **136** can engage the next tooth. The cylinder is again operated to extend the fixture to engage the next tooth, with consequent pivoting or the locking element **137** until the latter comes into engagement with the initial tooth When the drum is thus indexed, the output ends of the cooking tubes **94** of array **92***c* filled with fully cooked product and intermediate forming plugs **208** are immediately adjacent the finished product and plug delivery assembly **65** (i.e., the output ends of tubes **94** are in alignment with the input ends **419** of the smaller diameter tubular outlets **414**, **418**). Additionally, the input ends of the tubes **94** of array **92***c* are immediately adjacent the water outlets **376** of water ejection assembly **63**. The empty tubes **94** of array **92***b* are in alignment with the smaller diameter bores **472** of oiling assembly **68**. Finally, the outlet ends of the empty tubes **94** of array **92***a* are in alignment with the delivery elements **265** of the plug and meat emulsion injection subassembly **182**.

Next, the pancake cylinders **244** of subassembly **180** are actuated in order to shift the latter towards housing **70** until the open ends of the delivery elements **265** come into mating engagement with the inlet ends of the cooking tubes **94** of array **92***a* (FIG. **35**), and the water outlets **376** are similarly engaged with the inlet ends of the tubes **94** of array **92***c* (FIG. **41**). At substantially the same time, the pancake cylinders **408** and **466** of the assemblies **65** and **68** are actuated, which serves to shift these assemblies toward the outlet end of the housing **70**. This causes the outlets **414**, **418** to come into mating engagement with the output ends of the tubes **94** of array **92***c*, and the ends of the bores **472** to matingly engage the output ends of the tubes **94** of array **92***b*.

Ejection of cooked product and plugs **208** from the tubes **94** of array **92***c* is accomplished by directing pressurized water from block **372** and outlets **376** into these tubes behind the closest plugs **208** (FIG. **41**). The product and plugs **208** thus progressively pass through the tubes **94** and **414**, **418**, and are ultimately deposited onto moving conveyor **384**. This moves the cooked product away from housing **70** and towards output end **390** of the conveyor for further processing or packaging. If desired, the products may be sprayed with a substance in order to assist with skin formation and/or color development in the cooked product (e.g., acetic acid or white vinegar) or the like in the spray housing **392**. The intermediate plugs **208** are handled by the subassembly as described hereafter. At the end of the product and plug ejection sequence, the water within the tubes **94** of array **92***c* passes out of the tubes and descends though the conveyor **384** where it is collected in trough **432** and disposed of through outlet **434**.

Oiling of the tubes **94** of array **92***b* is effected by directing a pressurized mixture of lecithin and vegetable oil though the nipple **493** of block **462** for passage through inlets **492** immediately behind the swab pistons **486**. This progressively moves the swab pistons through the length of the tubes **94** (FIG. **44**), and simultaneously pulls the rods **490** from the oil tubes **478**, **482** until the rearmost pistons **487** seat within the block **462** (FIG. **45**). At this point the forward faces of the pistons **487** are adjacent the oil outlets **494**. Pressurized lecithin/oil is introduced through the outlets **494**, which causes rearward movement of the pistons **487** and consequent retraction of the rods **490** and swab pistons **486** to the original positions thereof. This in turn creates a very thin film of lecithin/oil on the inner surfaces of the tubes **94** of the array **92***b*, which assists in filling thereof with meat emulsion and plugs **208** when the housing **74** is indexed to the next position. It will be appreciated that lecithin/oil application may not be required if the cooking tubes are formed of other types of materials.

Referring now to FIGS. **28-33**, the sequential operation of the plug and meat emulsion injection subassembly **182** is illustrated, depicting the filling of the tubes **94** of array **92***a* from the beginning and through a complete cycle. It will be understood in this respect that these tubes have been previously oiled, as described above, and are ready to be filled with the plugs **208** and meat emulsion portions. FIG. **28** illustrates the subassembly **182** in its standby mode, with a series of plugs **208** located within each of the channels **210**, **212** of magazine **186**, and with meat emulsion **590** within the passageways of block **366**.

FIG. **29** illustrates the subassembly **182** in its first operational position with the tubular element **265** operatively coupled with cooking tubes **94**. In addition, this FIGURE depicts the initial insertion and seating of plugs **208** into the inserts **326** of plate **310**. This is accomplished by appropriate actuation of the cylinder **352**, which shifts the plug injection and seating rods **348** through the corresponding adjacent openings **215***a* and passageway structures **215** in order to shift the lowermost plug **208** within each channel toward and into the inserts **326**. Any residual air present in the leading concavities of the seated plugs **208** is removed by means of a vacuum drawn through fittings **268**.

FIG. **30** illustrates the next steps wherein the rods **348** have been withdrawn, thereby allowing the next adjacent plugs **208** to descend into loading positions. Further, the plate **310** has been shifted downwardly by actuation of the cylinder **312** to a second position wherein the inserts **326** are in alignment with the tubular elements **265**, and the first stages of the cylinders **330** have been actuated to extend the rods **344** so as to move the initially-seated plugs **208** into the delivery elements **265**. A vacuum drawn through the fittings **298** serves to remove air from the trailing concave face of the previously injected plugs **208**. This downward shifting of the plates **310** also aligns the through-openings **322** with those of plate **310** with the meat emulsion conveying openings **290** of plate **272**, and with the meat emulsion delivery openings **279** of plate **270**. In this fashion, the initial portions or charges of meat emulsion **590** are drawn by actuation of the cylinders **328** into the portioning chambers **340**.

FIG. **31** illustrates the next steps wherein the plate **310** is shifted upwardly to the position of FIG. **29**. This has two principal functions. First, the oblique passageways **320** are moved so as to communicate the portioning chambers **340** with the delivery elements **265**, allowing actuation of the cylinders **328** in order to move the previously drawn initial portions of emulsion **590** from the chambers **340** into and through the delivery elements **265** and against the trailing face of the previously injected initial plugs **208**. Second, the passageway **324** with inserts **326** therein are again located for loading of succeeding plugs **208** into the inserts **326**, via the action of the cylinder **352** and rods **348**.

FIG. **31**A illustrates an additional embodiment wherein pressurized air is directed either continuously or intermittently against the rearward faces of the initially injected plugs **208** during filling of the tubes **94**. As illustrated, a sealing plug and tubular injector assembly are used for air injection, as indicated by the arrow, with the sealing plug operatively engaging the output end of the tube. The pressurized air serves to inhibit any undo forward movement of these plugs away from the adjacent meat portions, owing to the speed of operation of the system **50**.

It is also contemplated that pressurized air may be injected into the cooking tubes during emulsion cooking, either con-

tinuously or intermittently throughout all or a portion of the cooking sequence. This serves to cook the emulsion under positive pressure to assist in product formation. In such a situation, a plurality of the sealing plug and tubular injector assemblies would be positioned adjacent to the output ends of the tubes **94**, and would be shiftable into engagement with the output ends, in the manner of the assemblies **65** and **68**. Hence, during indexing movement of the housing **70**, the sealing plug and tubular injector assemblies would be retracted, and once the housing **70** was indexed to its next position, these assemblies would be moved back into operative engagement with the outlet ends of the tubes **94**. This serves to cook the emulsion portions under compressive pressure within the tubes **94**.

FIG. **32** illustrates the plate **310** downwardly shifted to the FIG. **30** position, with the next succeeding plugs **208** being shifted through actuation of the second stages of cylinders **330**, which moves the plugs **208** through the delivery elements **265** and into the cooking tubes **94**. Finally, FIG. **33** illustrates the plate **310** again shifted so as to allow portions of meat emulsion **590** to be drawn into the portion chambers **340**, for the next step of the tube loading operation.

It will thus be appreciated that the tubes **94** of array **92***a* will be successively filled with plugs **208** and intermediate portions of meat emulsion. This operation is facilitated by the presence of the thin film of lecithin/oil on the inner surfaces of the tubes **94**. In this fashion, all of the portions are cooked to essentially the same degree. The lecithin/oil coating has been found to facilitate ejection of cooked product from the tubes **94**, without disrupting the skinned surfaces of the products.

As explained, the steps of filling the tubes **94** of array **92***a*, the application of oil to the tubes **94** of array **92***b*, and the ejection of cooked product and plugs from the tubes **94** of array **92***c*, occur substantially simultaneously. Once these steps are completed for a given set of arrays **92***a*-**92***c*, the assemblies **63**, **65**, and **68**, and subassembly **182**, are separated from the ends of the tubes **94** by operation of the associated pancake cylinders, to assume the standby positions thereof. This permits a further indexing operation of the housing **70** using the indexing drive **130**, whereupon the foregoing assemblies and subassemblies are again moved into operative engagement with the tubes **94** and the above steps repeat.

As the housing **70** is successively indexed and the tubes **94** of the arrays are filled with meat emulsion and plugs, cooking of the emulsion portions within the tubes is carried out. The system **50** is operated so that by the time filled tubes **94** successively reach the ejection assembly **63** and the finished product and plug delivery assembly **65**, the emulsion portions are cooked to the desired degree.

The plug recovery assembly **66** operates essentially continuously and serves to pick up the plugs **208** from the belt **384** and direct these plugs to the plug elevators **184**. In this regard, two streams of cooked product and plugs **208** are successively deposited upon the conveyor **386**. As the plugs reach the magnetic roller **40**, they are separated from the cooked products and two parallel streams of plugs pass along the conveyor belt **438**. At the end of the belt **438**, the plugs are transferred to the individual conveyors **450** and **452**. This serves to move the plugs **208**, again in separate plug streams, to the respective plug elevators **184** where the plugs are picked up by the magnetic pickups **196**. The plugs then descend through movement of the roller chains **188** until they reach the detachment segments **216** of the channels **210**, **212** (FIG. **9**). This causes the detachment of the plugs **208** from the pickups **196**, allowing the plugs to descend into the channels for reuse, as described.

As indicated, during production operations of system **50**, the plug storage assembly **69** is not used. However, during system shutdown, for purposes of cleanup or size changeover, the plugs **208** are collected, and assembly **69** is used for this purpose. Accordingly, the proper sized rack **564** or **566** is inserted into each unit **518** by sliding the racks into the spaces above the depending walls **573** until the racks engage the rack stops **567**. Next, the racks are elevated using the assemblies **568** so that the screws **588***a* thereof engage the undersides of the corner blocks **525** and raise the racks to their loading positions in the units **518**.

FIGS. **24** and **25** illustrate the filling of a rack **564** in a unit **518**. Specifically, the forward gate **549** is first extended, which stops the flow of plugs to the associated plug elevator **184**. Continued movement of the belt **450** causes succeeding plugs **208** to come into abutment and accumulate. This continues until a full row of plugs **208** is collected, whereupon the second gate **548** is actuated to prevent further plugs from entering the unit **518**.

At this point, the roller **556** is rotated so as to pick up the entire row of plugs **208** between the gates, and to deposit this row onto a flight **542**. As the roller chains **538** continue to move, the transferred row of plugs **208** is moved downwardly along the path of wall **562** until the row of plugs is deposited on the proximal recess provided in the plug rack **564**. This operation is continued and as additional plug rows are created and transferred, the flights **542** move the previously collected plug rows to successive plug recesses spaced from roller **556**.

When the rack **564** is filled, the rack elevator assembly **568** is actuated to lower the filled rack out of the path of the chain flights **542**, allowing the filled rack to be removed from the unit **518**. Specifically, the assembly **568** is operated to shift the filled rack **564** supported on the screws **588***a* to the lowered position thereof, thereby permitting sliding withdrawal of the filled rack from the unit **518**.

The above description has focused on the production of smaller diameter hot dog-type products making use of the smaller diameter cooking tubes **94** and related components. When it is desired to produce larger diameter products, the tubes **96** are used and the previously described change parts are installed on the system **50** in lieu of the smaller diameter change parts (see, e.g., FIG. **36**). The slide frame **230** is also shifted to its alternate, lowered position. All other operations in the production of the larger diameter products are the same as those described previously.

In preferred forms, the tubes **94**, **96** and all other meat emulsion-conveying components are the system **50** are formed from extruded Teflon. It has been found that this material gives an advantageous balance between cooking efficiency while avoiding problems of sticking and the like, which can degrade the integrity of the finished products. In other instances, however, materials such as stainless steel may be used.

The provision of plug-retaining shoulders **265***c* on the elements **265**, and shoulders **97** on the cooking tubes **94**, **96** is important in that it inhibits backward travel of the plugs **208** after insertion thereof. It has been found that without such shoulders, the plugs **208** can migrate backwardly, owing to the pressure conditions within the tubes, and thus disrupt production. The shoulders **265***c* and **97** have been found to mitigate this problem. However, along with the shoulders **97**, positive pressure air or mechanical stops could be employed at the input ends of the tubes **94** after complete filling thereof as an additional means of preventing backward migration of the plugs **208**. In the former case, seal and injector assemblies of the type illustrated in FIG. **31**A could be employed.

The preferred embodiment of the invention makes use of cooking tubes **94**, **96**, which are axially fixed, and operating assemblies **62**, **63** and **68**, which move axially relative to the cooking tubes between standby and operating positions. FIG. **49** illustrates an embodiment wherein alternate cooking tubes, such as tube **96***a*, are axially shiftable and are provided with a biasing spring **144** serving to urge the cooking tubes rightwardly. In this case, a tube-displacing mechanism including actuator **150***a* is provided to engage the beveled ends **150** of the tubes **96***a*. In operation, the mechanism engages the ends **150** and axially shifts the tubes **96***a* against the bias of the springs **144** and into mating engagement with a forward emulsion and plug filling assembly. At the same time, filled tubes **96***a* engage an ejector device which serves to push the contents of the filled tubes rearward and out the tube ends.

We claim:

1. An apparatus for creating and at least partially cooking elongated, comestible products such as meat products without the use of casings, said apparatus comprising:

a cooking assembly including an enclosed, shiftable housing defining an internal chamber and having a pair of end walls, a plurality of separate, individual cooking tubes extending through said housing and presenting respective longitudinal axes and first and second opposed ends, the interiors of said tubes being out of communication with said chamber;

a loading station including a loading structure operable to load comestible material into one of the first and second ends of said tubes;

a shifting mechanism operable to successively shift said cooking assembly in a first direction transverse to the longitudinal axes of said tubes and into said loading station for loading of said tubes when the tubes are shifted into said loading station,

said chamber adapted to hold a heating medium operable to at least partially cook the comestible material within said tubes; and

a discharge station separate from said loading station and including a discharge structure operable to discharge said at least partially cooked comestible material from said tubes,

said shifting mechanism operable to successively shift said cooking assembly in a second direction transverse to the longitudinal axes of said tubes and into said discharge station for discharge thereof,

said tubes being arranged in a generally circular pattern with the tubes substantially parallel with each other and circumferentially spaced apart, said first tube ends being inlet ends and said second tube ends being outlet ends, said first and second ends of said tubes being outboard of the pair of end walls, said shifting mechanism operable to incrementally and rotationally shift said cooking assembly so that the respective inlet ends of the tubes are moved into said loading station for individual loading of said tubes,

said shifting mechanism operable to incrementally move said cooking assembly having said tubes containing said at least partially cooked comestible material into said discharge station for discharge of the at least partially cooked comestible material from said outlet ends of the tubes,

said loading station further including a structure for injecting a series of plugs into said tubes so that the tubes have individual portions of said comestible material with plugs on opposite ends of each of the individual portions and engaging each of the individual portions,

said series of plugs shiftable along the lengths of said tubes in order to shift said individual portions of said comestible material from said tubes to said discharge station.

2. The apparatus of claim **1**, said first and second directions being the same.

3. The apparatus of claim **1**, said cooking assembly operable to heat each of said tubes after said loading of said tubes in said loading station and until each of the tubes reach said discharge station, and said heating medium operable to heat said comestible material.

4. The apparatus of claim **1**, each of said series of plugs having opposed concave ends, said loading structure including a device for withdrawing air from said concave ends during injection of said series of plugs.

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